# Low Radioactivity Techniques Workshop - LRT2013

# Report of Contributions

https://agenda.infn.it/e/lrt2013

Contribution ID: **0** Type: **oral presentation**

# Radiopurity control in the NEXT-100 double beta decay experiment

*Wednesday, 10 April 2013 12:10 (20 minutes)*

An extensive screening and material selection process is underway in the construction of the "Neutrino Experiment with a Xenon TPC"(NEXT), intended to investigate neutrinoless double beta decay using a high-pressure xenon gas TPC filled with 100 kg of Xe enriched in 136Xe. Determination of the radiopurity levels of the materials is based on gamma-ray spectroscopy using ultra-low background germanium detectors at the Laboratorio Subterráneo de Canfranc (Spain) and also on Glow Discharge Mass Spectrometry. Materials to be used in the shielding, pressure vessel, electroluminescence and high voltage components and energy and tracking readout planes have been already taken into consideration. The measurements carried out will be presented, describing the techniques and equipment used, and the results obtained will be shown, discussing their implications for the NEXT experiment.

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**Presenter:** Dr CEBRIAN, SUSANA (UNIVERSITY OF ZARAGOZA)

**Session Classification:** Session 3 - Low background counting techniques

**Track Classification:** Low background counting techniques

Contribution ID: **1** Type: **poster**

# Background studies for NaI(Tl) detectors in the ANAIS dark matter project

*Thursday, 11 April 2013 15:00 (1h 20m)*

Several large NaI(Tl) detectors, produced by different companies, have been operated in the Canfranc Underground Laboratory (LSC) in the frame of the ANAIS (Annual modulation with NaI Scintillators) project devoted to the direct detection of dark matter.
For those detectors, activities from the natural chains of 238U and 232Th and 40K in the NaI(Tl) crystals have been evaluated. Discrimination of alpha particles vs. beta/gamma background by Pulse Shape Analysis (PSA) has been applied for quantifying the content of the natural chains while coincidence techniques were used for 40K. A description of the methods followed and the presentation of the main results in this background characterization of NaI(Tl) detectors will be made.
In particular, a complete background model has been developed for a 9.6 kg detector after several months of data taking in Canfranc. Radioactive contaminations in the main detector and shielding components have been determined by different complementary techniques, including HPGe spectrometry. Then, Monte Carlo simulations using Geant4 package have been carried out to evaluate their contribution. At high energies, most of the measured background is nicely reproduced; at low energy some non-explained components are still present, although some plausible background sources have been analyzed. The NaI(Tl) crystal has been confirmed to be the dominant contributor to the measured background.
Finally, preliminary data about cosmogenic induced activity in NaI(Tl) detectors obtained with two NaI(Tl) crystals, 12.5 kg mass each, recently produced and being characterized at this moment in Canfranc will be presented.

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**Session Classification:** Poster session

**Track Classification:** Low background counting techniques

Contribution ID: **2** Type: **poster**

# Low-Background Gamma-Ray Spectrometry in the Garching Underground Laboratory

*Thursday, 11 April 2013 15:00 (1h 20m)*

We present two screening setups located in the Garching Underground Lab at a shallow depth of 10 m.w.e. One screening station consists of a 150% efficiency HPGe detector surrounded by an anti-Compton veto made of a NaI(Tl) scintillation detector. In addition, a passive lead shielding, a N2 flushed box and muon veto panels complete the setup.
With this setup we reach sensitivities down to 1 mBq/kg for U-238 and Th-232. The integral count rate in the energy range from 40-2700 keV is 10250+-26 cts/day.
The second newly set-up screening station consists of two smaller HPGe detectors arranged face-to-face which are also surrounded by a passive lead shielding, a N2 flushed box and muon veto panels. The integral count rate in the energy range from 20-1500 keV is 5258+-27 cts/day and 6876+-31 cts/day for the two detectors, respectively.

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**Session Classification:** Poster session

**Track Classification:** Screening facilities and low background detectors

Contribution ID: **3** Type: **oral presentation**

# Development of radiopure cadmium tungstate crystal scintillators from enriched 106Cd and 116Cd to search for double beta decay

*Friday, 12 April 2013 10:15 (20 minutes)*

Cadmium tungstate crystal scintillators enriched in 106Cd up to 66% (106CdWO4) and 116Cd up to 82% (116CdWO4) have been developed to investigate double beta processes in 106Cd and 116Cd. The metal samples of the enriched cadmium were purified by heating with filtration in combination with distillation through getter filters. The cadmium tungstate compounds were synthesized from solutions by using quartz or polypropylene lab-ware, materials with low level of radioactive contaminations, and reagents of high purity grade (concentration of any metal less than 0.01 ppm). The 106CdWO4 and 116CdWO4 crystal boules with masses of 231 g and 1868 g, respectively (87% of initial charges) were grown by the low-thermal-gradient Czochralski technique. The total irrecoverable losses of the isotopically enriched materials in the whole production processes do not exceed 2%. The produced scintillators exhibit excellent optical and scintillation properties thanks to the deep purification of the initial materials and utilization of the low-thermal-gradient Czochralski method to grow the crystals. Radioactive contamination of the scintillators was measured both by scintillation method and using ultra-low-background HPGe gamma detectors. The contamination of the crystals is on the level of <1.5 mBq/kg (40K), <0.005-0.012 mBq/kg (226Ra), 0.04-0.07 mBq/kg (228Th), 2-3 mBq/kg (total alpha activity). We have observed a considerable activity of 113mCd in both the crystals: 116 Bq/kg in the 106CdWO4 and 0.46 Bq/kg in the 116CdWO4. The measurements of the scraps of the melt after the 116CdWO4 crystal growth by using an ultra-low-background HPGe detector indicate a very low segregation of thorium, radium and potassium, which gives a strong motivation to re-crystallize the crystals with an aim to improve further their radiopurity in 228Th and 226Ra. Experiments to search for double beta processes in 106Cd and 116Cd by using the crystal scintillators are in progress at the underground Gran Sasso National Laboratories of the INFN (Italy).

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**Session Classification:** Session 7: Low background purification and growth techniques for liquids and solids

**Track Classification:** Low background purification and growth techniques for liquids and solids

Contribution ID: **4** Type: **oral presentation**

# GIOVE, a new low-background Ge-spectrometer at MPI-K

*Wednesday, 10 April 2013 10:20 (20 minutes)*

A new germanium gamma spectrometer (GIOVE) has been added to the screening facility of the MPI for Nuclear Physics to meet the needs for material selection for the double beta and dark matter projects Gerda Phase II [1] and XENON 1T [2]. It bridges the gap in sensitivity between the GeMPI spectrometers at LNGS [3, 4] and the older generation low background spectrometers at the Heidelberg low level laboratory [5]. The background rate at Heidelberg, originally two orders higher compared to the Gran Sasso based spectrometers is mainly due to events induced by incompletely vetoed muons and by higher neutron flow as well as by a higher cosmogenic activation rate. Progress in radio-purity of the detector materials is a further reason.

GIOVE (Germanium spectrometer with Inner and Outer VEto) has two independent veto systems consisting of plastic scintillator plates and a neutron moderator interlayer of borated polyethylene (PE) in its Pb/Cu shield. Further neutron moderation is obtained through the plastic scintillator layers.
All materials used in the construction of the cryostat and the shield were selected by extensive radio purity measurements with the existing spectrometers. Not all demands in radio-purity could be met and thus compromises had to be made. One example is the residual about 80 mBq/kg 40K contamination of the purest boron compound we were able to find at reasonable cost. It prohibited to place the borated PE at the most favourable position, namely between the innermost Pb layer and the Cu gladding around the detector chamber.
Especially challenging was the light readout of the inner plastic scintillators. Here, low activity 1”x1”PMTs have been used, similar to the ones originally selected for the XENON100 dark matter detector [6].
The addition of neutron moderation layers made the shield too bulky for the sample chamber to be accessed from the outside. Therefore, samples are placed into Cu containers which are lowered into the sample chamber hanging under the before raised shielding plug. Rn suppression is achieved by a nitrogen purged air lock/glove box system and gas tight sample containers.

The double veto system reduces the total background rate (40-2700 keV) from 2.8x104 to 293 counts (d kg)-1 and thus only one decade apart from the GeMPI spectrometers.
Further performance and constructional details of GIOVE will be discussed. The Monte Carlo simulation of the full setup including the characterisation of the germanium diode will be described.

[1] Gerda proposal to LNGS, September 2004
[2] XENON 1t proposal to LNGS, April 2010
[3] Heusser G., M. Laubenstein, H. Neder, radionuclides in the environment, edited by P. P. Povinec and J. A. Sanchez-Cabeza, Elsevier, Amsterdam (2006) 495-510
[4] Rugel G. et al., Nuclear Physics B (Proc. Suppl.) 143 (2005) 564
[5] Aberle C. et al., MPI-K Progress Report (2010) 258-259
[6] Aprile E. et al. (XENON100), Astropart.Phys.35 (2011) 43-49

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**Session Classification:** Session 2 - Screening facilities and low background detectors

**Track Classification:** Screening facilities and low background detectors

Contribution ID: **5** Type: **poster**

# Purification of lanthanides for double beta decay experiments

*Thursday, 11 April 2013 15:00 (1h 20m)*

There are many potentially double beta active isotopes among the lanthanide elements (136Ce, 138Ce, 142Ce, 146Nd, 148Nd, 150Nd, 144Sm, 154Sm, 152Gd, 160Gd, 156Dy, 158Dy, 162Er, 164Er, 170Er, 168Yb, 176Yb). However, even the high purity grade (99.99% - 99.995%) lanthanide compounds contain typically uranium and thorium on the level of ~ (0.1 - 1) Bq/kg. We present results of chemical purification of cerium, neodymium, and gadolinium oxides by using a combination of physical and chemical methods. The liquid-liquid extraction technique was used to remove traces of Th and U from neodymium, gadolinium and for the purification of cerium from Th, U, Ra and K. Co-precipitation and recrystallization methods were utilized for further reduction of the impurities. The radioactive contamination of the samples before and after the purification procedure was tested by using ultra-low-background HPGe gamma spectrometry at the underground Gran Sasso National Laboratories of the INFN (Italy). As a result of the purification procedure the radioactive contamination of gadolinium oxide (a similar purification efficiency was reached also with cerium and neodymium oxides) was decreased from 0.12 Bq/kg to 0.007 Bq.kg in 228Th, from 0.04 Bq/kg to <0.006 Bq/kg in 226Ra, and from 0.9 Bq/kg to 0.04 Bq/kg in 40K. However, the purification method is much less efficient for chemically very similar radioactive elements like lanthanum, lutetium and actinium. R&D of the methods to separate the lanthanides with improved efficiency are in progress.

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**Session Classification:** Poster session

**Track Classification:** Fabrication methods and surface contamination control

Contribution ID: **6** Type: **poster**

# Screening Materials with the XIA UltraLo Alpha Particle Counter at Southern Methodist University

*Thursday, 11 April 2013 15:00 (1h 20m)*

Southern Methodist University in Dallas Texas houses one of only five existing UltraLo 1800 production model alpha counters made by XIA LLC. The instrument has an electron drift chamber with a 707 cm^3 or 1800 cm^3 counting region which is determined by selecting the inner electrode size. The SMU team operating this device is part of SuperCDMS screening working group, and uses the alpha counter to study the background rates from the decay of radon in materials used to construct the SuperCDMS experiment. We will present results from our initial calibration and screening runs with the XIA instrument, and will outline our plans for upcoming work to facilitate SuperCDMS to achieve it's goal to limit the experiment's beta backgrounds to a level of less than 0.003 events/cm2/day.

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**Presenter:** NAKIB, Mayisha (SMU)

**Session Classification:** Poster session

**Track Classification:** Low background counting techniques

Contribution ID: **8** Type: **oral presentation**

# Low-background tracker development for the SuperNEMO experiment

*Thursday, 11 April 2013 12:25 (20 minutes)*

The SuperNEMO experiment will search for 0νββ with a target half-life sensitivity of 10^26 years, corresponding to an effective neutrino mass of 50 - 100 meV.
At its heart there is a low-background gaseous tracking detector which allows for extremely efficient background rejection and, if 0νββ is observed, may provide important insights into the mechanism via which it may be mediated.

Radon inside the tracker is one of the most dangerous backgrounds for SuperNEMO which can mimic rare ββ events. To reach the target sensitivity the radon concentration inside the tracking volume must be less than 0.15 mBq/m^3. The focus of the talk will be on the development of a 'Radon Concentration Line' in order to measure these low levels of Rn in sub-modules of the tracking detector during its construction and commissioning.

We will also describe the development of new detector seals that drastically reduce Rn diffusion inside the detector. Finally the development of an automated wiring process will be presented which is used to minimise the chance of contamination during manufacturing of the tracker.

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**Presenter:** Mr MOTT, James (UCL)

**Session Classification:** Session 6: Cosmogenic activation and low background techniques in experiments

**Track Classification:** Cosmogenic activation and low background techniques in experiments

Contribution ID: **9** Type: **oral presentation**

# Background suppression in the EDELWEISS-III experiment

*Thursday, 11 April 2013 12:05 (20 minutes)*

In dark matter WIMP searches the neutron shielding plays a crucial role in attenuating neutron flux and hence, suppressing nuclear recoil event rate - one of the key background mimicking WIMP interactions. The transition from EDELWEISS-II to EDELWEISS-III with 40 detectors with increased mass and improved background rejection has required the modification of the neutron shielding. In this paper we describe the new neutron shielding design and give an estimate of the expected neutron rate in comparison with the previous stage of the experiment.

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**Session Classification:** Session 6: Cosmogenic activation and low background techniques in experiments

**Track Classification:** Cosmogenic activation and low background techniques in experiments

Contribution ID: **10** Type: **oral presentation**

# Background characterization for the GERDA experiment

*Thursday, 11 April 2013 12:45 (20 minutes)*

The GERDA experiment at LNGS searches for the neutrinoless double beta (0nubb) decay of Ge-76. HPGe detectors made from germanium enriched in Ge-76 are directly immersed in liquid argon, serving as shield against external radiation and as a cooling medium simultaneously. A significant reduction of the background compared to previous experiments is achieved in the first phase of the experiment. An analysis of the first 13.7 kg*yr of Phase I data resulted in a good understanding of the individual background components in the background energy spectrum. A dedicated analysis for the measurement of the half-life of the two-neutrino double beta (2nubb) decay of Ge-76 showed that the 2nubb decay of Ge-76 is the dominating source in the 600 keV - 1800 keV region, with a signal-to-background ratio of 4:1.

The background in a 160 keV energy region around the Q-value of Ge-76 double beta decay Qbb = 2039 keV, i.e., from 1939 keV to 2139 keV excluding the central 40 keV blinded window, has been identified to be mainly due to beta- and/or gamma-induced events originating from Bi-214 (U-238 series), Tl-208 (Th-232 series), K-42 (progeny of Ar-42) and alpha-induced events coming from the alpha emitting radioisotopes in the Ra-226 decay chain. A background decomposition around the Qbb will be presented with special emphasis on the contribution from alpha-induced events.

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**Session Classification:** Session 6: Cosmogenic activation and low background techniques in experiments

**Track Classification:** Cosmogenic activation and low background techniques in experiments

Contribution ID: **11** Type: **oral presentation**

# Measurement and reduction of low-level radon background in the KATRIN experiment

*Thursday, 11 April 2013 09:50 (20 minutes)*

The KArlsruhe TRItium Neutrino (KATRIN) experiment is a large-scale experiment for the model independent determination of the mass of electron anti-neutrinos with a sensitivity of 200 meV/c^2. It investigates the kinematics of electrons from tritium beta decay close to the endpoint of the energy spectrum. Low statistics at the endpoint requires an equally low background rate below 10^-2 counts per second. The measurement setup consists of a high luminosity windowless gaseous tritium source (WGTS), a magnetic electron transport system with differential and cryogenic pumping for tritium retention, and an electro-static spectrometer section (pre-spectrometer and main spectrometer) for energy analysis, followed by a segmented detector system for counting transmitted beta-electrons.

The KATRIN measurement requires a total background rate below 10^-2 counts per second. Initial measurements at a test setup with the KATRIN pre-spectrometer, revealed a rate well above this limit, coming from radon decays inside the spectrometer volume. Two main sources have been identified, the vacuum getter pump, which emanates mainly Rn-219 with a half-life of 4 s, and the stainless steel of the vacuum chamber of the spectrometer, emanating Rn-220 with a half-life of 56 s. Long-lived radon isotopes are of no concern, since they can be pumped out of the sensitive volume before they decay. Neutral radon atoms are able to penetrate deep into the magnetic flux tube of the spectrometer where they eventually decay. Electrons, produced in various processes during or after the alpha decay of Rn, are guided magnetically to the detector where they contribute to the background rate. Of particular importance are electrons emitted in processes such as shake-off, internal conversion of excited levels in the Rn daughter atoms and Auger electrons. Low-energy electrons (< 100 eV) can directly leave the spectrometer towards the detector. High-energy electrons are usually stored magnetically for hours inside the spectrometer, where they can create thousands of secondary electrons via subsequent ionization processes with residual gas molecules. Thus already one radon decay can produce enough background events for one day.

This talk will give an overview of observed Rn sources and subsequent processes in the KATRIN spectrometer and describes different passive and active counter measures, which have been tested at the pre-spectrometer to reduce the Rn induced background rate. Direct consequences for the design of the large main spectrometer (volume 1240 m^3) are discussed.

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**Session Classification:** Session 5: Purification/control techniques from radioactive noble gases

**Track Classification:** Purification/control techniques from radioactive noble gases

Contribution ID: **13** Type: **oral presentation**

# Control of Radon-Induced Contamination in the DEAP-3600 Acrylic Vessel

*Wednesday, 10 April 2013 17:35 (20 minutes)*

DEAP-3600 is a 3600kg single-phase liquid-argon dark matter detector under construction at SNOLAB. The argon is held an an acrylic vessel which is optically transparent at the shifted wavelength of 420 nm; an effective neutron shield; and physically strong.

Because the acrylic (Poly Methyl MethAcrylate) is in contact with the liquid argon it can be a source of alpha-induced backgrounds. To achieve a background rate of less than 0.01 events in the 1000-kg fiducial volume per year of exposure the allowed limit of Pb-210 in the bulk acrylic is 10^{-20}g/g. We discuss how pure acrylic was procured and manufactured into a complete vessel paying particular attention to exposure to radon during all processes. In particular field work at RPT Asia (the supplier of the acrylic panels) and
ThaiMMA (supplier of the monomer Methyl MethAcylate) in Thailand is described. The increased diffusion of radon during annealing the acrylic at 85C as well as techniques to mitigate against this are described.

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**Session Classification:** Session 4 - Fabrication methods and surface contamination control

**Track Classification:** Fabrication methods and surface contamination control

Contribution ID: **14** Type: **poster**

# Modeling surface alpha backgrounds from radon progeny plate-out

*Thursday, 11 April 2013 15:00 (1h 20m)*

The next generation low-background detectors operating deep underground aim for unprecedented low levels of radioactive backgrounds. The surface deposition and subsequent implantation of radon progeny in detector materials will be a source of energetic background events. We investigate Monte Carlo and model-based simulations to understand the surface implantation profile of radon progeny. Depending on the material and region of interest of a rare event search, these partial energy depositions can be problematic. Motivated by the use of Ge crystals for the detection of neutrinoless double-beta decay, we wish to understand the detector response of surface backgrounds from radon progeny. We look at the simulation of surface decays using a validated implantation distribution based on nuclear recoils and a realistic surface texture. Results of the simulations and measured alpha spectra is presented.

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**Session Classification:** Poster session

**Track Classification:** Background studies, models, and simulations

Contribution ID: **15** Type: **poster**

# HEROICA: a fast screening facility for the characterization of germanium detectors

*Thursday, 11 April 2013 15:00 (1h 20m)*

Erica Andreotti for the GERDA BEGe acceptance test group

In the course of 2012, a facility for fast screening of germanium detectors called HEROICA (Hades Experimental Research Of Intrinsic Crystal Appliances) has been installed at the HADES underground laboratory in the premises of the Belgian Nuclear Research Centre SCK.CEN, in Mol (Belgium).
The HEROICA facility allows the determination of all typical germanium detectors'operational parameters within a short time frame and it consists of:
1. Two static tables, with a lead shield surrounding the detector, suitable for measurements with a test source placed in fixed positions: this set-up is used for the determination of the energy resolution, the active volume, the average deadlayer and other detector properties;
2. Three automated mechanical set-ups, provided with a movable, motor-controlled arm, which allow performing a full surface scanning of the diode with a collimated source: the primary scope is to study the deadlayer and charge collection variations.
The set-ups are coupled to complementary data acquisition systems, both analog (MCA) and digital (FADC), which are run in parallel thanks to automated scripts developed on purpose.
The high level of automation allows a fast characterisation of larger batches of diodes in reasonable time. Additionally, the overburden of 225 m guarantees a limited cosmic activation of the germanium detectors and of the equipment. The proximity of HADES to the germanium diode manufacturer Canberra N.V. in Olen (about 30 km distance) is also advantageous. The HEROICA testing area was first commissioned in the framework of the characterisation of Broad Energy Germanium (BEGe) detectors for the second phase of the GERDA experiment. It completely fulfilled the requirements of the 30 BEGe diode production: flexibility during the diode production and testing phase, reduced exposure to cosmic radiation and screening of two diodes/week on average. Following-up screening activities with natural Germanium diodes are in preparation.
To summarize, HEROICA has proven to be an adequate screening facility for fast, detailed and almost background-free detector characterization. This will be of major interest especially for next generation rare event physics experiments based on a large number of detectors.

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**Session Classification:** Poster session

**Track Classification:** Cosmogenic activation and low background techniques in experiments

Contribution ID: **16** Type: **poster**

# The BetaCage, an Ultra-sensitive Screener for Surface Contamination

*Thursday, 11 April 2013 15:00 (1h 20m)*

Material screening for identifying low-energy electron emitters and alpha-decaying isotopes is now a prerequisite for rare-event searches (e.g., dark-matter direct detection and neutrinoless double-beta decay) for which surface radiocontamination has become an increasingly important background. The BetaCage, a gaseous neon time-projection chamber, is a proposed ultra-sensitive (and nondestructive) screener for alpha- and beta-emitting surface contaminants to which existing screening facilities are insufficiently sensitive. The expected sensitivity is 0.1 betas (per keV-m^2-day) and 0.1 alphas (per m^2-day), where the former will be limited by Compton scattering of external photons in the screening samples and (thanks to tracking) the latter is expected to be signal-limited; radioassays and simulations indicate backgrounds from detector materials and radon daughters should be subdominant. We will report on details of the background simulations and detector design that provide the discrimination, shielding, and radiopurity necessary to reach our sensitivity goals for a chamber with a 95x95 cm^2 sample area positioned below a 40 cm drift region and monitored by crisscrossed anode and cathode planes consisting of 151 wires each.

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**Presenter:** Dr BUNKER, Raymond (Syracuse University)

**Session Classification:** Poster session

**Track Classification:** Fabrication methods and surface contamination control

Contribution ID: **17** Type: **poster**

# GAMMA3 : A GAMMA/ELECTRON SPECTROMETRY SYSTEM FOR DETECTION OF ENVIRONMENTAL FISSION PRODUCTS TRACES

*Thursday, 11 April 2013 15:00 (1h 20m)*

Identification and quantification of minute quantities of fission/activation products in environmental samples is often of primary importance for the characterization of radiological events in various fields: nuclear power plant accidents, detection of clandestine nuclear tests in the framework of CTBT (Comprehensive Test Ban Treaty), nuclear forensics… Sensitivity of conventional surface-level system is limited by natural environmental background whereas for underground systems the performances are often hampered by the Compton background signal due to natural or major anthropogenic radionuclides present in the sample.
In order to achieve the best detection capabilities for both low and high activity samples, a versatile triple crystal gamma spectrometer has been designed and is currently under implementation in our laboratory. The setup is composed of three mobile high efficiency HPGe spectrometers. This structure can accommodate several types of environmental samples: full or compressed aerosol filters, bottles ranging from 20 to 1000 cm3, gas cells.
State-of-the art passive and active shielding techniques are implemented. The multiple crystal setup allows to perform (□-□) coincidence/anti-coincidence measurements. This increases drastically the detection capabilities of the system for several relevant fission products. For quantification of radioactive noble gas a special 15 cm3 carbon-window cylindrical measurement cell fitted with two large area passively implanted silicon detectors (PIPS) has been built. This cell is placed in between two of the HPGe detectors. This configuration allows to perform (X,e-) coincident detection of radioxenon isotopes. This is of particular interest for unambiguous detection of metastable radioxenon isotopes (131mXe, 133mXe) which are relevant for discrimination between civilian and military events.

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**Presenter:** Dr DOUYSSET, GUILHEM (CEA)

**Session Classification:** Poster session

**Track Classification:** Screening facilities and low background detectors

Contribution ID: **18** Type: **oral presentation**

# GERDA Phase II detectors: behind the production and characterisation at low background conditions

*Wednesday, 10 April 2013 13:10 (20 minutes)*

The low background GERmanium Detector Array (GERDA) at Laboratori Nazionali del Gran Sasso is designed to search for the rare neutrino-less double beta decay (0vbb) in 76Ge. Bare germanium diodes are operated in liquid argon that is used as coolant, as passive and soon active as well shield against external radiation. Currently, Phase I of the experiment is running using ~15 kg of co-axial Germanium diodes. In order to increase the sensitivity of the experiment ~30 Broad Energy Germanium (BEGe) diodes will be added within 2013. The additional target mass of ~20 kg, the better energy resolution and the enhanced pulse shape discrimination of background events through these novel detectors will drastically improve the sensitivity of the experiment.
This presentation reviews the production chain of the new BEGe detectors from isotopic enrichment to diode production and testing. As demonstrated all steps were carefully planned in order to minimize the exposure of the enriched germanium to cosmic radiation. Cosmogenically-induced radioisotopes in germanium such as 68Ge, 60Co or 58Co are namely a serious hazard that mimics rare events of interest like 0vbb decays. Following this premise, acceptance and characterisation measurement of the newly produced diodes have been performed within the HEROICA project in the Belgian underground laboratory HADES close to the diode manufacturer. The full test program, including advanced investigations of diode properties, is discussed. It includes the determination of parameters essential for GERDA such as energy resolution, depletion voltage, charge collection efficiency, dead layer, active volume fraction and pulse shape performance. Results from a subset of the recently terminated GERDA Phase II BEGe survey will be presented.

**Primary author:** MANESCHG, Werner (Max Planck Institut fuer Kernphysik)

**Presenter:** MANESCHG, Werner (Max Planck Institut fuer Kernphysik)

**Session Classification:** Session 3 - Low background counting techniques

**Track Classification:** Low background counting techniques

Contribution ID: **19** Type: **poster**

# Measurement and modeling of muon-induced neutrons in LSM in application for direct Dark Matter searches

*Thursday, 11 April 2013 15:00 (1h 20m)*

Due to a very low event rate expected in direct Dark Matter search experiments, a good understanding of every background component is crucial. Muon-induced neutrons constitute a prominent background, since neutrons lead to nuclear recoils and thus can mimic a potential Dark Matter signal. Edelweiss is a Ge-bolometer experiment searching for WIMP dark matter. It is located in the Laboratoire Souterrain de Modane (LSM, France). We have measured muon-induced neutrons by means of a neutron counter based on Gd-loaded liquid scintillator. Studies of muon-induced neutrons will be presented and include development of the appropriate MC model based on GEANT4 and analysis of a 1000-days measurement campaign in LSM. We find a good agreement between measured rates of muon-induced neutrons and those predicted by the developed model with full event topology. The impact of the neutron background on current Edelweiss data-taking as well as for next generation experiments such as EURECA will be discussed.
This work is supported in part by the German ministry of science and education (BMBF Verbundforschung ATP Proj.-Nr. 05A11VK2) and by the Helmholtz Alliance for Astroparticle Phyics (HAP) funded by the Initiative and Networking Fund of the Helmholtz Association.

**Primary author:** Dr KOZLOV, Valentin (Karlsruhe Institute of Technology)

**Presenter:** Dr KOZLOV, Valentin (Karlsruhe Institute of Technology)

**Session Classification:** Poster session

**Track Classification:** Background studies, models, and simulations

Contribution ID: **20** Type: **poster**

# A Micromegas detector for 222Rn emanations measurements

*Thursday, 11 April 2013 15:00 (1h 20m)*

The 222Rn emanation has significant contribution in the overall background for rare event searches experiment, in order to measure this emanations a high sensitivity detector have been designed with the aim of a minimum detectable activity of 100 μBq. The detection method is the electrostatic collection of the 222Rn daughters on a Micromegas detector. Using a chamber with a volume of 21.2 l for the collection of 218Po and 214Po progeny of 222Rn and a 12 x 12 cm2 pixelized Micromegas for the α detection. The advantages of the Micromegas detectors are the low intrinsic radioactivity and the track reconstruction of α, having excellent capabilities for event discrimination.

**Primary author:** Mr GARCIA PASCUAL, Juan Antonio (Universidad de Zaragoza)

**Presenter:** Mr GARCIA PASCUAL, Juan Antonio (Universidad de Zaragoza)

**Session Classification:** Poster session

**Track Classification:** Screening facilities and low background detectors

Contribution ID: **21** Type: **oral presentation**

# ICP MS measurement of natural radioactivity at LNGS

*Wednesday, 10 April 2013 15:20 (20 minutes)*

The assembly of physics experiments searching for rare events involves the selection of highly radio-pure materials. The possibility to measure natural radioactivity (potassium, thorium and uranium) in a wide range of materials and with the best available sensitivity is of basic importance in this field of research. Inductively coupled plasma mass spectrometry (ICP MS) allows the direct identification and quantification of almost all the stable elements and long-lived radionuclides in the periodic table in a wide variety of matrix. A quadrupole and a double focusing analyzer mass spectrometers are available at the Gran Sasso National Lab Chemistry Service. Depending on the sample nature, it's possible to achieve different levels of sensitivity. Some examples of applications will be presented.

**Primary authors:** BALATA, Marco (INFN - LNGS); Ms DI VACRI, Maria Laura (INFN - LNGS); NISI, Stefano (INFN - LNGS)

**Presenter:** NISI, Stefano (INFN - LNGS)

**Session Classification:** Session 3 - Low background counting techniques

**Track Classification:** Screening facilities and low background detectors

Contribution ID: **22** Type: **oral presentation**

# The Prototype BetaCage: A prototype time-projection chamber material screener for radioisotope surface contamination

*Wednesday, 10 April 2013 12:30 (20 minutes)*

The BetaCage is a proposed neon time-projection chamber for the ultra-sensitive screening of materials for alpha- and beta-emitting surface contaminants. The BetaCage is of interest to rare-event-search experiments (e.g. dark matter searches and neutrino less double-beta decay) where surface contaminations from the implantation of the products from radon decays are a substantial background. A prototype device, measuring 40 cm x 40 cm screening area with a 20 cm drift field sandwiched between two multi-wire proportional grids, has been constructed and is currently operating at Caltech. We will report on the progress of this prototype device and, in particular, measurements of low-energy x-ray and alpha sources.

**Primary author:** Dr NELSON, Robert (Caltech)

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**Presenter:** Dr NELSON, Robert (Caltech)

**Session Classification:** Session 3 - Low background counting techniques

**Track Classification:** Low background counting techniques

Contribution ID: **23** Type: **oral presentation**

# Radon adsorption in nanoporous carbon materials

*Thursday, 11 April 2013 10:10 (20 minutes)*

The background from the Radon decay chain is the strongest constraint for many experiments working at low energy and very low counting rate in particle and astroparticle physics. Classically, activated charcoal filters are used to dynamically capture the radon from the air or from the gas of the detectors. The activated charcoal has large effective surface and broad porosity, going from macro to nanopores, and in general is a good adsorptive material. However, the big constraints from futures experiments need ad hoc radon capture filters. The optimal adsorption depends however on the correct pore size, the temperature, pressure, the microscopic structure of the adsorbent and the completion between the different components of the gas. In this context, we have developed at Centre de Physique des Particules de Marseille (CPPM), a test bench to study the radon capture in new and more selective porous materials. Several very interesting results have been already obtained with non-standard commercially available adsorbents like Metal Organic Frame Work (MOF), Carbon Molecular Sieves (CMS), etc. In parallel to this work, and in order to achieve the extremely high radio-purity requirements of our experiments, we are developing in collaboration with the Centre Interdisciplinaire de NAnosciences de Marseille (CINAM) a new research methodology based on dendrimers and their carbonaceous polymeric derivatives. We will present the results obtained up to now and the prospective of our facility.

**Primary author:** Prof. BUSTO, Jose (CPPM / SuperNEMO Collaboration)

**Presenter:** Prof. BUSTO, Jose (CPPM / SuperNEMO Collaboration)

**Session Classification:** Session 5: Purification/control techniques from radioactive noble gases

**Track Classification:** Purification/control techniques from radioactive noble gases

Contribution ID: **24** Type: **oral presentation**

# BiPo: A dedicated radiopurity detector for the SuperNEMO experiment

*Wednesday, 10 April 2013 17:55 (20 minutes)*

New generation experiments in Astroparticle Physics need to operate in really restrictive background conditions, which implies the use of high radiopure materials for the experimental setup construction. For this reason the screening of the materials with enough sensitivity has become a challenge that sometimes cannot be afforded with standard techniques like Germanium detector spectroscopy.

BiPo is a dedicated detector, that operates in the Canfranc Underground Laboratory, designed to measure the radiopurity, mainly of the bb sources of the SuperNEMO experiment, by the detection of BiPo events. It is composed of two modules with 40 optical lines each that register the energy and the time of the emitted particles. The well known features of the BiPo events (delayed coincidence between an electron and an alpha particle) facilitate the discrimination of other background events that could entangle the expected signal. In addition, the geometry of the detector, with an active area of around 3.6 m^2, has been optimized to reach the necessary sensitivity levels for the SuperNEMO source foils in the shortest time possible.

First results of background measurements and calibrations taken from last summer shows that the required sensitivity for the measurements of the source foils could be reached in few months. Routine measurements of samples will start in the next months being a really important point for the SuperNEMO source foils construction.

**Primary author:** Dr GOMEZ, HECTOR (Laboratoire de l'Accélérateur Linéaire (LAL-Orsay))

**Presenter:** Dr GOMEZ, HECTOR (Laboratoire de l'Accélérateur Linéaire (LAL-Orsay))

**Session Classification:** Session 4 - Fabrication methods and surface contamination control

**Track Classification:** Fabrication methods and surface contamination control

Contribution ID: **25** Type: **oral presentation**

# Low Background Counting at the LBNL Low Background Facility

*Wednesday, 10 April 2013 11:50 (20 minutes)*

The Low Background Facility (LBF) at Lawrence Berkeley National Laboratory in Berkeley, California operates in two unique facilities—locally within a carefully-constructed, low background cave; and remotely at an underground location (~500 m.w.e) nearby in Oroville, CA. These facilities provide a variety of gamma spectroscopy services to low background experiments primarily in the form of passive material screening for primordial radioisotopes (U, Th, K) or common cosmogenic/anthropogenic products, as well as active screening via Neutron Activation Analysis for specific applications. A general overview of the facilities, services, and sensitivities will be discussed. Recent activities and upgrades will also be presented, including the recent installation of a 3π muon veto at the surface station, addition of old Pb to counting shields, and environmental monitoring of Fukushima fallout.

**Primary author:** THOMAS, Keenan (UC Berkeley- Dept. of Nuclear Engineering, LBNL - NSD)

**Co-authors:** SMITH, Alan R. (Lawrence Berkeley National Laboratory - NSD); HURLEY, D.L. (Lawrence Berkeley National Laboratory - NSD); NORMAN, Eric B. (UC Berkeley- Dept. of Nuclear Engineering, LBNL - NSD); CHAN, Yuen-Dat (Lawrence Berkeley National Laboratory - NSD)

**Presenter:** THOMAS, Keenan (UC Berkeley- Dept. of Nuclear Engineering, LBNL - NSD)

**Session Classification:** Session 2 - Screening facilities and low background detectors

**Track Classification:** Screening facilities and low background detectors

Contribution ID: **26** Type: **poster**

# Demonstration and Details of the Community Material Assay Database

*Thursday, 11 April 2013 15:00 (1h 20m)*

The physics community has a wealth of knowledge about the radiopurity of materials used to design and construct experiments requiring ultra-low backgrounds which is shared through various databases, publications and informally. The aim of this Community Material Assay Database is to consolidate these data into a single concise and comprehensive central repository, and to provide a robust interface to interact with the different data elements. This database is managed by the CouchDB database management system, which is a portable, extensible NoSQL solution. A web interface front-end is under development that provides users several methods for searching and viewing data, submitting data, and providing feedback. The interface was designed to be extensible for any user and has several methods for searching and viewing data. The data structure is designed to be flexible and extensible. The initial implementation of this database will contain data obtained from various international sources, such as the ILIAS project and publications from the EXO and BOREXINO collaborations. The database is accessible at http://radiopurity.org.

**Primary authors:** WISE, Benjamin (Southern Methodist University); ADLER, Keith (Southern Methodist University); BRUEMMER, Matthew (Southern Methodist University)

**Co-authors:** COX, Adam (KIT/Edelweiss); POON, Alan W. P. (LBNL); Dr LOACH, James (LBNL/Majorana); Dr COOLEY, Jodi (Southern Methodist University); NGUYEN, Khan (Southern Methodist University)

**Presenters:** Dr LOACH, James (LBNL/Majorana); Dr COOLEY, Jodi (Southern Methodist University)

**Session Classification:** Poster session

**Track Classification:** Overview of global radioactivity measurement facilities

Contribution ID: **27** Type: **oral presentation**

# Construction and measurements of a vacuum-swing-adsorption radon mitigation system

*Thursday, 11 April 2013 10:30 (20 minutes)*

In order to reduce backgrounds from radon-daughter plate-out onto the wires of the BetaCage during its assembly, an ultra-low-radon cleanroom is being commissioned at Syracuse University. Air sampling measurements taken before connecting the vacuum-swing-adsorption radon mitigation system demonstrate the effectiveness of air circulation through standard HEPA filters at reducing the concentration of radon daughters in the cleanroom. I will describe details of implementation of the radon mitigation system and measurements of the concentration of radon and radon daughters.

**Primary author:** Prof. SCHNEE, Richard (Syracuse University)

**Co-authors:** Mr JARDIN, Dan (Syracuse University); Mr GHULAM, Gogee (Syracuse University); Dr BUNKER, Raymond (Syracuse University)

**Presenter:** Prof. SCHNEE, Richard (Syracuse University)

**Session Classification:** Session 5: Purification/control techniques from radioactive noble gases

**Track Classification:** Purification/control techniques from radioactive noble gases

Contribution ID: **28** Type: **poster**

# Removal of long-lived 222Rn daughters by electropolishing thin layers of stainless steel

*Thursday, 11 April 2013 15:00 (1h 20m)*

Long-lived alpha and beta emitters in the Rn-222 decay chain on detector surfaces may be the limiting background in many experiments attempting to detect dark matter or neutrinoless double beta decay. Removal of tens of microns of material via electropolishing has been shown to be effective at removing radon daughters implanted into material surfaces. Some applications, however, require the removal of uniform and significantly smaller thicknesses. Here, we demonstrate that electropolishing < 1 micron from stainless steel plates efficiently reduces surface contamination. Examination of electropolished wires with a scanning electron microscope confirms that the thickness removed is reproducible and reasonably uniform. Together, these tests demonstrate the effectiveness of removal of radon daughters for a proposed low-radiation, multi-wire proportional chamber (the BetaCage), without compromising the screener's energy resolution. More generally, electropolishing thin layers of stainless steel may be an effective means of removing radon daughters without compromising precision-machined parts.

**Primary author:** Prof. SCHNEE, Richard (Syracuse University)

**Co-authors:** Mr WHITE, James (Syracuse University); Ms MCCABE, Kelley (Syracuse University); Mr PEPIN, Mark (University of Minnesota); Mr BOWLES, Michael (Syracuse University); Prof. CUSHMAN, Prisca (University of Minnesota); Dr BUNKER, Raymond (Syracuse University); Prof. GUISEPPE, Vincente (University of South Dakota)

**Presenter:** Prof. SCHNEE, Richard (Syracuse University)

**Session Classification:** Poster session

**Track Classification:** Fabrication methods and surface contamination control

Contribution ID: **29** Type: **oral presentation**

# A Community Material Assay Database

*Wednesday, 10 April 2013 18:35 (20 minutes)*

The physics community possesses a wealth of knowledge on the radiopurity of materials, which has been acquired laboriously during the design and construction of generations of ultra-low background experiments. To the extent that this information has been shared, it has been done so through databases of limited scope or availability, through publications and through informal exchanges. The aim of the Community Material Assay Database is to consolidate these data into a single comprehensive repository, in which the data is stored in a concise and flexible data format, and is accessible through a powerful web interface. This open-source database is built using the CouchDB NoSQL database engine. Assays are encoded and stored as JSON documents, and searched and edited using a client-side AJAX web application stored within the database itself. The software can also be used as a stand-alone application by experimental collaborations or counting facilities. The initial release contains data from the ILIAS project and publications by the EXO and BOREXINO collaborations. It is accessible at http://radiopurity.org

**Primary author:** Dr LOACH, James (Shanghai Jiaotong University)

**Co-authors:** Dr COX, Adam (KIT); Dr POON, Alan (LBNL); Mr WISE, Ben (Southern Methodist University); Prof. COOLEY, Jodi (SMU); ADLER, Keith (Southern Methodist University); Mr NGUYEN, Khang (LBNL); Mr BRUEMMER, Matthew (Southern Methodist University)

**Presenter:** Dr LOACH, James (Shanghai Jiaotong University)

**Session Classification:** Session 1: Overview of global radioactivity measurement facilities

**Track Classification:** Overview of global radioactivity measurement facilities

Contribution ID: **30** Type: **oral presentation**

# Short-lived Rn-222 daughters in cryogenic liquids

*Friday, 12 April 2013 10:35 (20 minutes)*

Presently cryogenic liquids are extensively used in experiments looking for
rare nuclear events at low energies, for which the main issue is reduction of background. One of its most important sources may be intrinsic radioactive impurities of the cryogenic gas. A method to investigate properties of the short-lived Rn-222 daughters present in liquid nitrogen will be presented. Since they are produced as positive ions they can move in electric filed created by the detector itself (e.g. in TPCs). Drift of radioactive ions may lead to their inhomogeneous distribution in the detector's active volume and thus influence the expected background signal. Measurements of the ionic life-time and mobilities will be discussed.

**Primary author:** Mr PELCZAR, Krzysztof (Institute of Physics, Jagiellonian University)

**Presenter:** Mr PELCZAR, Krzysztof (Institute of Physics, Jagiellonian University)

**Session Classification:** Session 7: Low background purification and growth techniques for liquids and solids

**Track Classification:** Low background purification and growth techniques for liquids and solids

Contribution ID: **31** Type: **poster**

# Simulation of low-level tritium and radon background in the KATRIN main spectrometer

*Thursday, 11 April 2013 15:00 (1h 20m)*

The KArlsruhe TRItium Neutrino (KATRIN) experiment is a large scale experiment for the model independent determination of the mass of electron anti-neutrinos with a sensitivity of 200 meV/c^2. It investigates the kinematics of electrons from tritium beta decay close to the endpoint of the energy spectrum at 18.6 keV. Low statistics at the endpoint requires an equally low background rate below 10^-2 counts per second. The measurement setup consists of a high luminosity windowless gaseous tritium source (WGTS), a magnetic electron transport system with differential and cryogenic pumping for tritium retention, and an electro-static retarding spectrometer section (pre-spectrometer and main spectrometer) for energy analysis, followed by a segmented detector system for counting transmitted beta-electrons.

A major source of background comes from magnetically trapped electrons in the main spectrometer (vacuum vessel: 1240 m^3, 10^-11 mbar) produced by nuclear decays in the magnetic flux tube of the spectrometer. Major contributions are expected from short-lived radon isotopes and tritium. Primary electrons, originating from these decays, can be trapped for hours, until they have lost almost all their energy through inelastic scattering on residual gas particles. Depending on the initial energy of the primary electron, hundreds of low energetic secondary electrons can be produced, which are able to leave the spectrometer, adding to the background rate.

This talk will describe the simulation methods and presents results from simulations of various background sources. Decays of Rn-219, emanating from the main vacuum pump, and tritium from the WGTS that reaches the spectrometer account for most of the background. Although the radon is undergoing an alpha decay, electrons are emitted through various processes, such as shake-off, internal conversion and Auger electrons.

The simulation was done using the KASSIOPEIA framework, which has been developed for the KATRIN experiment for low energy electron tracking, field calculation and detector simulation. The results of the simulations have been used to optimize the design parameters of the vacuum system with regard to radon emanation and tritium pumping, in order to reach the stringent requirements of the neutrino mass measurement.

**Primary author:** Mr LEIBER, Benjamin (Institute for Nuclear Physics, Karlsruhe Institute of Technology)

**Co-authors:** Mr FURSE, Daniel (MIT); Dr GLUECK, Ferenc (KIT); FRAENKLE, Florian (Department of Physics and Astronomy, University of North Carolina at Chapel Hill); Prof. DREXLIN, Guido (KIT); Dr WOLF, Joachim (KIT); Dr HOETZEL, Markus (KIT); Mrs WANDKOWSKY, Nancy (KIT); Mr GOERHARDT, Stefan (KIT); Dr MERTENS, Susanne (KIT); Dr THUEMMLER, Thomas (KIT); Dr KAEFER, Wolfgang (KIT)

**Presenter:** Mr LEIBER, Benjamin (Institute for Nuclear Physics, Karlsruhe Institute of Technology)

**Session Classification:** Poster session

**Track Classification:** Background studies, models, and simulations

Contribution ID: **32** Type: **oral presentation**

# Background Considerations for SuperCDMS

*Friday, 12 April 2013 12:30 (20 minutes)*

Rejection and protection from backgrounds is a key issue for the next generation SuperCDMS SNOLAB experiment which will have a cross-section sensitivity of 9^-46 cm^2 for spin-independent WIMP-nucleon interactions. We have identified 210Pb as the dominant source of electromagnetic background seen in our detectors through a study that correlates the alpha and beta particles resulting from this decay. I will discuss details of this analysis and the methods of rejecting electromagnetic backgrounds possible with our new iZIP detectors currently operated in the Soudan Underground Laboratory. I will also comment on methods the collaboration is investigating to protect against neutron backgrounds in the next generation SuperCDMS experiment.

**Primary author:** Dr COOLEY, Jodi (SMU)

**Presenter:** Dr COOLEY, Jodi (SMU)

**Session Classification:** Session 8: Background studies, models, and simulations

**Track Classification:** Background studies, models, and simulations

Contribution ID: **33** Type: **oral presentation**

# The COUPP detector and the acoustic alpha background discrimination technique.

*Thursday, 11 April 2013 11:45 (20 minutes)*

The nature of non-baryonic dark matter (DM) is one of the most intriguing questions for particle physics at the start of the 21st century. The Chicagoland Observatory for Underground Particle Physics (COUPP) employs a CF3I bubble chamber to search for WIMP-nucleus elastic scattering events. In this communication we show the plans, status and results of COUPP in the different bubble chamber generations (4 kg, 60 kg and 500 kg). We will put, as well, special attention to the acoustic technique employed to be able to discriminate bubbles from alphas allowing a large background reduction and thus increasing the sensitivity

**Primary authors:** Mr FELIS, Ivan (UPV); Dr BOU-CABO, Manuel (UPV); Dr ARDID, Miguel (UPV)

**Presenter:** Dr BOU-CABO, Manuel (UPV)

**Session Classification:** Session 6: Cosmogenic activation and low background techniques in experiments

**Track Classification:** Cosmogenic activation and low background techniques in experiments

Contribution ID: **35** Type: **poster**

# Acoustic studies for alpha background rejection in dark matter bubble chambers detectors

*Thursday, 11 April 2013 15:00 (1h 20m)*

The Chicagoland Observatory for Underground Particle Physics (COUPP) employs bubble chambers to detect WIMP-nucleus interactions. Acoustic techniques have been successfully used in order to reduce alpha background. In this communication we present our studies to better understand the generation, propagation and detection of acoustic signals in bubble chambers, the simulation tools developed and the acoustic test bench that is being developed to validate the tools. The aim of the studies is to optimize the acoustic systems and the analysis techniques for the third generation (500 kg) bubble chamber. Moreover, the first results of these studies give some hints on how to design more efficient and adapted piezoelectric sensors and where to locate them.

**Primary authors:** Mr FELIS, Ivan (UPV); Dr BOU-CABO, Manuel (UPV); Dr ARDID, Miguel (UPV)

**Presenter:** Dr BOU-CABO, Manuel (UPV)

**Session Classification:** Poster session

**Track Classification:** Screening facilities and low background detectors

Contribution ID: **37** Type: **poster**

# Low background techniques in SuperNEMO

*Thursday, 11 April 2013 15:00 (1h 20m)*

This talk will give an overview of all the low background techniques used in the SuperNEMO collaboration to build a “zero-background” demonstrator module.

**Primary author:** Mr PERROT, Frédéric (CENBG)

**Presenter:** Mr PERROT, Frédéric (CENBG)

**Session Classification:** Poster session

**Track Classification:** Cosmogenic activation and low background techniques in experiments

Contribution ID: **38** Type: **oral presentation**

# Krypton in XENON

*Thursday, 11 April 2013 09:30 (20 minutes)*

Natural krypton contains the long-lived β-decaying isotope 85Kr which
represents for liquid xenon detectors looking for low-energetic, rare events a dangerous source of background. Within the scope of the XENON experiments we developed a dedicated tool based on mass-spectrometry to assay the krypton concentration in small xenon samples at the ppt-level. In my talk I will shortly review the XENON project using the example
of the XENON100 experiment and focussing on the knowledge gained on
the krypton background. In detail I will present the mass-spectrometry tool (RGMS) at MPIK, Heidelberg, and present a variety of results obtained with this apparatus as well as their impact on the understanding of the XENON100 background.

**Primary author:** Mr LINDEMANN, Sebastian (Max-Planck-Institut fuer Kernphysik)

**Presenter:** Mr LINDEMANN, Sebastian (Max-Planck-Institut fuer Kernphysik)

**Session Classification:** Session 5: Purification/control techniques from radioactive noble gases

**Track Classification:** Purification/control techniques from radioactive noble gases

Contribution ID: **39** Type: **poster**

# New setup for low Radon emanation rate measurements

*Thursday, 11 April 2013 15:00 (1h 20m)*

A new large setup designed to measure low Radon emanation rates will be described.

**Primary author:** SOULÉ, Benjamin (Centre d'études nucléaires de Bordeaux Gradignan (CENBG))

**Co-authors:** Mr CERNA, Cédric (CENBG); Mr PERROT, Frédéric (CENBG)

**Presenter:** SOULÉ, Benjamin (Centre d'études nucléaires de Bordeaux Gradignan (CENBG))

**Session Classification:** Poster session

**Track Classification:** Low background counting techniques

Contribution ID: **40** Type: **poster**

# Measurements of Cosmic Ray Correlated Events at the Soudan Underground Laboratory

*Thursday, 11 April 2013 15:00 (1h 20m)*

Soudan Underground Laboratory houses a large muon veto shield lining the Soudan-II proton decay
experimental cavern. Since the Soudan-II detector has been removed the shield has undergone a refurbishment which allows detection and tracking of through-going muons in the 30x17x12 m cavern.
Further, this veto shield can be used in conjunction with other experiments housed within its walls. Particularly interesting is the possible measurement of cavern muons coincident with high-energy energy neutron detections in the Neutron Multiplicity Meter (NMM), a 4-ton gadolinium-loaded water-Cherenkov
detector situated atop a 20-kiloton lead target. Here we cover the ability of the shield and encapsulated
detectors to achieve coincident timing resolutions of about 1 microsecond via GPS-synchronized absolute
time electronics. In addition, the usage of such technology for constraining muon-neutron correlations
underground is discussed.

**Primary authors:** Dr VILLANO, Anthony (University of Minnesota); Prof. CUSHMAN, Priscilla (University of Minnesota); Dr BUNKER, Raymond (Syracuse University)

**Presenter:** Dr VILLANO, Anthony (University of Minnesota)

**Session Classification:** Poster session

**Track Classification:** Screening facilities and low background detectors

Contribution ID: **41** Type: **oral presentation**

# Radon induced surface contaminations in low background experiments

*Wednesday, 10 April 2013 16:25 (20 minutes)*

In neutrinoless double beta decay and dark matter searches, one of the main issues is to increase the experimental sensitivity through careful material selection and production, minimizing the background contributions. In order to achieve the required, extremely low, counting rates, very stringent requirements must be fulfilled in terms of bulk material radio-purity. As the experimental sensitivity increases, the bulk impurities in the detector components decrease, and surface contaminations start to play an increasingly significant role.

In fully active detectors, like cryogenic particle detectors, surface contaminations are a critical issue (as shown by the CUORICINO experiment). Rn-222 is by far the most intense source of airborne radioactivity, and if a radio-pure material is exposed to environment where the Radon concentration is not minimized, Pb-210 and Po-210 contaminations can occur. The mechanisms and the dynamics of Radon-induced surface contaminations are reviewed, and specific solutions to prevent and to reject the induced background are presented.

**Primary author:** Dr PATTAVINA, Luca Maria (Milano Bicocca University)

**Presenter:** Dr PATTAVINA, Luca Maria (Milano Bicocca University)

**Session Classification:** Session 4 - Fabrication methods and surface contamination control

**Track Classification:** Fabrication methods and surface contamination control

Contribution ID: **42** Type: **oral presentation**

# A Comprehensive Comparison for Simulations of Cosmic Ray Muons Underground

*Friday, 12 April 2013 12:50 (20 minutes)*

The two leading simulation frameworks used for the simulation of cosmic ray muons underground are Geant4 and FLUKA. There have been in the past various questions raised as to the equivalence of
these codes regarding cosmogenically produced neutrons and radioactivity in an underground environment.
Many experiments choose one of these frameworks and because they typically have different geometries and
are located at different underground sites the issues relating to code comparison are compounded.
We report on an effort to compare the results of each of these codes in simulations which have simple
geometry which is consistent between the two codes. This comparison results in a way to get good constraints
on how the physics of each of the simulation packages differ. The methodology employed lends itself to
easier benchmarking in the future and the comparisons suggest the most important observables to consider of
the many possible observables in the simulations.

**Primary authors:** Dr VILLANO, Anthony (University of Minnesota); Dr EMPL, Anton (University of Arkansas at Little Rock); Dr CUSHMAN, Priscilla (University of Minnesota)

**Presenter:** Dr VILLANO, Anthony (University of Minnesota)

**Session Classification:** Session 8: Background studies, models, and simulations

**Track Classification:** Background studies, models, and simulations

Contribution ID: **43** Type: **poster**

# Calibration of an Ultra-Low-Background Proportional Counter for Measuring Ar-37

*Thursday, 11 April 2013 15:00 (1h 20m)*

A new ultra-low-background proportional counter (ULBPC) design was recently developed at Pacific Northwest National Laboratory (PNNL) using clean materials, primarily electrochemically-purified copper. This detector, along with an ultra-low-background counting system (ULBCS), has been developed to complement a new shallow underground laboratory (30 meters water-equivalent) constructed at PNNL. The ULBCS design includes passive neutron and gamma shielding, along with an active cosmic-veto system. This system provides a capability for making ultra-sensitive measurements to support applications like radon emanation assay of low-background materials, age-dating of groundwater tritium, and soil-gas assay for Ar-37 to support On-Site Inspection (OSI). On-Site Inspection is a key component of the verification regime for the Comprehensive Nuclear-Test-Ban Treaty (CTBT). Measurements of radionuclides created by an underground nuclear explosion are a valuable signature of a Treaty violation. For OSI, the 35-day half-life of Ar-37, produced from neutron interactions with calcium in soil, provides both high specific activity and sufficient time for inspection before decay limits sensitivity. This work describes the calibration techniques and analysis methods developed to enable quantitative measurements of Ar-37 samples over a broad range of pressures. These efforts, along with parallel work in progress on gas chemistry separation, are expected to provide a significant new capability for Ar-37 soil gas background studies.

**Primary author:** Dr SEIFERT, Allen (Pacific Northwest National Laboratory)

**Co-authors:** Mr MYERS, Allan (Pacific Northwest National Laboratory); Mr DAY, Anthony (Pacific Northwest National Laboratory); Mr LAFERRIERE, Brian (Pacific Northwest National Laboratory); Mr OVERMAN, Cory (Pacific Northwest National Laboratory); Dr AALSETH, Craig (Pacific Northwest National Laboratory); Mrs MACE, Emily (Pacific Northwest National Laboratory); Dr HOPPE, Eric (Pacific Northwest National Laboratory); Mr FULLER, Erin (Pacific Northwest National Laboratory); Mr MERRIMAN, Jason (Pacific Northwest National Laboratory); Mr PANISKO, Mark (Pacific Northwest National Laboratory); Dr KEILLOR, Martin (Pacific Northwest National Laboratory); Dr BONICALZI, Ricco (Pacific Northwest National Laboratory); Dr WILLIAMS, Richard (Pacific Northwest National Laboratory)

**Presenter:** Dr SEIFERT, Allen (Pacific Northwest National Laboratory)

**Session Classification:** Poster session

**Track Classification:** Screening facilities and low background detectors

Contribution ID: **44** Type: **oral presentation**

# The Ultra Pure Titanium for the low background experiments.

*Thursday, 11 April 2013 13:05 (20 minutes)*

Due to the large mass of the cryostats, containment tanks, passive shielding, and other mechanical parts of the modern low background detectors, requirements on their radiopurity are typically stringent. In this regard, the material radiopurity has to be less then 1 mBq/kg of U238 / Th232, which means that mass concentration should be < 0.1 ppb for U and < 0.25 ppb for Th.
Traditionally, the field relies on specially selected low background stainless steel, electrochemical oxygen-free copper, or a combination of the two. But the most promising material in terms of physical and mechanical properties is titanium (or its alloys).
Our analysis of various Ti samples together with external similar studies, show that the levels of contaminations of commercially available industrial titanium varies from 0.2 to 400 mBq/kg for U/Th. There fore, the only possible way to obtain the material with a low and controlled level of contamination is to develop (or improve the existing) the production technology and to build the dedicated manufactory line.

**Primary author:** Dr CHEPURNOV, Alexander (Moscow State University)

**Co-author:** Dr SUVOROV, Yury (Ucla & INFN - LNGS)

**Presenters:** Dr CHEPURNOV, Alexander (Moscow State University); Dr SUVOROV, Yury (Ucla & INFN - LNGS)

**Session Classification:** Session 6: Cosmogenic activation and low background techniques in experiments

**Track Classification:** Cosmogenic activation and low background techniques in experiments

Contribution ID: **45** Type: **oral presentation**

# Low Background Counting Techniques At SNOLAB

*Wednesday, 10 April 2013 11:30 (20 minutes)*

Many of the experiments currently searching for dark matter, studying properties of neutrinos or searching for neutrinoless double beta decay require very low levels of radioactive backgrounds both in their own construction materials and in the surrounding environment. These low background levels are required so that the experiments can achieve the required sensitivities for their searches. SNOLAB has several facilities which are used to directly measure these radioactive backgrounds. This presentation will describe SNOLAB's High Purity Germanium Detectors, one of which has been in continuous use for the past seven years measuring materials for many experiments in operation or under construction at SNOLAB. A description of the characterisation of SNOLAB's new germanium well detector will be given. In addition, brief descriptions of SNOLAB's alpha-beta and electrostatic counters will be presented, and the radon levels at SNOLAB will be discussed.

**Primary author:** Dr LAWSON, Ian (SNOLAB)

**Presenter:** Dr LAWSON, Ian (SNOLAB)

**Session Classification:** Session 2 - Screening facilities and low background detectors

**Track Classification:** Screening facilities and low background detectors

Contribution ID: **50** Type: **oral presentation**

# Pattern recognition techniques to reduce backgrounds in the search for the 136Xe double beta decay with gaseous TPCs

*Wednesday, 10 April 2013 12:50 (20 minutes)*

The observation of the neutrinoless double beta decay may provide essential information on the nature of neutrinos. Among the current experimental approaches, a high pressure gaseous TPC is an attractive option for the search of double beta decay due to its good energy resolution and the detailed topological information of each event. We present in this talk a detailed study of the ionization topology of the 136Xe double beta decay events in high pressure xenon, as well as that of the typical competing backgrounds. We define some observables based on graph theory concepts to develop automated discrimination algorithms. Our criteria are able to reduce the background level by about three orders of magnitude in the region of interest of the 136Xe Q_bb for a signal acceptance of 40%. This result provides a quantitative assessment of the benefit of topological information offered by gaseous TPCs for double beta decay search, and proves that it is a promising feature in view of future experiments in the field. Possible ideas for further improvement in the discrimination algorithms and the dependency of these results with the gas diffusion and readout granularity will be also discussed.

**Primary author:** Dr IGUAZ GUTIERREZ, Francisco Jose (University of Zaragoza)

**Co-authors:** Mr TOMAS, Alfredo (University of Zaragoza); Ms HERRERA, D.C. (University of Zaragoza); Dr LUZON, Gloria (University of Zaragoza); Dr GOMEZ, Hector (Laboratoire de l'Accélérateur Linéaire (LAL)); Dr IRASTORZA, Igor (U. Zaragoza); Ms SEGUI, Laura (University of Zaragoza); Dr CEBRIAN, SUSANA (UNIVERSITY OF ZARAGOZA); Dr DAFNI, Theopisti (University of Zaragoza)

**Presenter:** Dr IGUAZ GUTIERREZ, Francisco Jose (University of Zaragoza)

**Session Classification:** Session 3 - Low background counting techniques

**Track Classification:** Low background counting techniques

Contribution ID: **51** Type: **oral presentation**

# AARM: Integrative Infrastructure for Low Background Techniques

*Wednesday, 10 April 2013 18:15 (20 minutes)*

The AARM (Assay and Acquisition of Radiopure Materials) collaboration was established for the purpose of designing a low background user facility at DUSEL. Over the last four years, it has been successful in uniting dark matter and double beta decay experiments around common issues of assay, simulation tools, and experimental validation of the physics processes underlying simulations. I will present the status and future plans of this group, which has another 2 years of funding under the Integrative Tools for
Underground Science initiative. Ways in which infrastructure for low
background studies can be coordinated worldwide will be discussed.

**Primary author:** Prof. CUSHMAN, Priscilla (University of Minnesota)

**Presenter:** Prof. CUSHMAN, Priscilla (University of Minnesota)

**Session Classification:** Session 1: Overview of global radioactivity measurement facilities

**Track Classification:** Overview of global radioactivity measurement facilities

Contribution ID: **53** Type: **poster**

# Radiopurity measurement of acrylic for DEAP-3600

*Thursday, 11 April 2013 15:00 (1h 20m)*

The spherical acrylic vessel that contains the liquid argon target is the most critical component in the DEAP-3600 dark matter experiment. Alpha decays near the inner surface of the acrylic vessel are one of the main sources of background in the detector. A fraction of the alpha energy, or the recoiling nucleus from the alpha decay, could misreconstruct in the fiducial volume and result in a false candidate dark matter event.
Acrylic has some inherent contamination, including U-238 and Th-232. Another background of particular concern is diffusion of Rn-222 during manufacturing. The maximum acceptable concentrations in the DEAP-3600 acrylic vessel are ppt levels of U-238, Th-232, and 10^-8 ppt of Pb-210.The impurities in the bulk acrylic will be measured by vaporizing a large quantity of acrylic and counting the concentrated residue with an ultra-low background HPGe well detector and a low background alpha spectrometer.
First results from the acrylic assay system at SNOLAB will be presented.

**Primary author:** Ms NANTAIS, Corina (Queen's University)

**Presenter:** Ms NANTAIS, Corina (Queen's University)

**Session Classification:** Poster session

**Track Classification:** Cosmogenic activation and low background techniques in experiments

Contribution ID: **54** Type: **oral presentation**

# A Fast Neutron Spectrometer for Underground Science

*Wednesday, 10 April 2013 10:40 (20 minutes)*

The University of Maryland and National Institute of Technology developed
the Fast Neutron Spectrometers (FaNS) as high efficiency, full-energy
reconstructing, neutron detectors. The first generation, FaNS-1, consisted of 18 liters of plastic scintillator, separated in six optically decoupled segments, and six $^{3}$He proportional counters. The detector operated under the principle of capture-gated spectroscopy, a technique that demands a delayed coincidence between a neutron thermalizing in the scintillator and then capturing in a helium counter. FaNS-1 was calibrated at NIST using $^{252}$Cf for efficiency and mono-energetic neutron generators, based on deuterium-deuterium and deuterium-tritium fusion, to test energy reconstruction. After measuring the surface fast neutron spectrum from 1 MeV to 150 MeV at NIST Gaithersburg, the detector was installed at the Kimballton Underground Research Facility in Ripplemead, VA, where it operated for two years. During this time FaNS-1 measured the fast neutron backgrounds from the surrounding rock, and placed a limit on the cosmic-ray spallation induced neutron flux. The fast neutron spectrum measured at KURF is presented along with the calibration and surface data.

An upgraded detector was designed to measure neutron energies from 250 keV to 2 GeV. FaNS-2 consists of sixteen segments of plastic scintillator, with total active volume of 73 liters, interspersed with 21 $^{3}$He proportional counters for thermal neutron detection. FaNS-2 was calibrated at NIST using a variety of sources; $^{252}$Cf spontaneous fission neutron sources, an AmBe $(\alpha, n)$ source, and two mono-energetic neutron generators. The absolute efficiency was also measured using the $^{252}$Cf source at multiple distances from the detector. All calibration data types are compared to detailed Monte Carlo simulations using MCNP. We present the fast neutron fluence and spectrum measured at 100 m above sea level for neutrons from 250 keV to 2 GeV. We discuss installation of FaNS-2 in a shallow underground lab at 100 meter water equivalent overburden.

**Primary author:** LANGFORD, Thomas (University of Maryland)

**Presenter:** LANGFORD, Thomas (University of Maryland)

**Session Classification:** Session 2 - Screening facilities and low background detectors

**Track Classification:** Screening facilities and low background detectors

Contribution ID: **55** Type: **poster**

# Initial Characterization of Unequal-Length, Low-Background Proportional Counters for Absolute Gas-Counting Applications

*Thursday, 11 April 2013 15:00 (1h 20m)*

Characterization of two sets of custom unequal length proportional counters is underway at Pacific Northwest National Laboratory (PNNL). These detectors will be used in measurements to determine the absolute activity concentration of gaseous radionuclides (e.g., 37Ar). A set of three detectors has been fabricated based on previous PNNL ultra-low-background proportional counters (ULBPC) designs and now operate in PNNL's shallow underground counting laboratory. A second set of four counters has also been fabricated using clean assembly of OFHC copper components for use in an above-ground counting laboratory. Characterization of both sets of detectors is underway with measurements of background rates, gas gain, energy resolution, and shielding considerations. These results will be presented along with uncertainty estimates of future absolute gas counting measurements.

**Primary author:** MACE, Emily (Pacific Northwest National Laboratory)

**Co-authors:** Dr SEIFERT, Allen (Pacific Northwest National Laboratory); DAY, Anthony R. (Pacific Northwest National Laboratory); LAFERRIERE, Brian (Pacific Northwest National Laboratory); OVERMAN, Cory T. (Pacific Northwest National Laboratory); Dr AALSETH, Craig E. (Pacific Northwest National Laboratory); Dr HOPPE, Eric W. (Pacific Northwest National Laboratory); FULLER, Erin S. (Pacific Northwest National Laboratory); Dr HAYES, James C. (Pacific Northwest National Laboratory); MERRIMAN, Jason (Pacific Northwest National Laboratory); Dr BONICALZI, Ricco M. (Pacific Northwest National Laboratory); Dr WILLIAMS, Richard M. (Pacific Northwest National Laboratory)

**Presenter:** MACE, Emily (Pacific Northwest National Laboratory)

**Session Classification:** Poster session

**Track Classification:** Screening facilities and low background detectors

Contribution ID: **56** Type: **oral presentation**

# Water Purification in Borexino

*Friday, 12 April 2013 10:55 (20 minutes)*

Water is used in the Borexino Solar Neutrino Experiment as a shielding against external gamma radiation, as well as a medium to be used in purification processes and cleaning of various part of the equipment.
The Borexino Water Purification System uses normal fresh Water (10^-3 Bq/kg of U-238,Th-232,K-40, 0.3 Bq/kg of Ra-226 and 10 Bq/kg of Rn-222) and makes use of various purification processes to impove radiopurity. Reverse Osmosis, Ultrafiltration, Continuous Deionization and Ga Stripping are used to improve purity.
The final results in term of radioactivity removal are of a factor of 1000 for U,Th,K, about five orders of magnitude for Ra-226 and six orders of magnitude for Rn-222

**Primary author:** GIAMMARCHI, Marco Giulio (MI)

**Co-authors:** IANNI, Andrea (Princeton University); GORETTI, Augusto (Princeton University); MIRAMONTI, Lino (MI); IOANNUCCI, Luca (LNGS); BALATA, Marco (LNGS); NISI, Stefano (LNGS)

**Presenter:** GIAMMARCHI, Marco Giulio (MI)

**Session Classification:** Session 7: Low background purification and growth techniques for liquids and solids

**Track Classification:** Low background purification and growth techniques for liquids and solids

Contribution ID: **58** Type: **oral presentation**

# Low background techniques from XMASS

*Wednesday, 10 April 2013 17:15 (20 minutes)*

An 800kg liquid xenon detector (XMASS) was constructed in Kamioka laboratory, Japan in 2010, and a commissioning run was conducted from November 2010 to June 2012. Although we have achieved the design level of internal backgrounds, it was found that surface contamination is the major contribution of the remaining background. The origins of the surface background have been extensively investigated and they were identified to be 1) The upstream portion of 238U decay chain and 210Pb found in the aluminum used for sealing PMTs materials, and 2) 210Pb on the inner surface of the detector.
In order to reduce these backgrounds, countermeasures have been devised and refurbishment of the detector is ongoing. Techniques for the reduction of detector surface contamination (covering of PMT aluminum, electro-polishing of surface elements) and keeping the assembly environment clean (control of low radon level, exposure time, electro statistic and dust) for the refurbishment work will be reported.

**Primary author:** Dr OGAWA, Hiroshi (Institute for Cosmic Ray Research University of Tokyo)

**Presenter:** Dr OGAWA, Hiroshi (Institute for Cosmic Ray Research University of Tokyo)

**Session Classification:** Session 4 - Fabrication methods and surface contamination control

**Track Classification:** Fabrication methods and surface contamination control

Contribution ID: **59** Type: **poster**

# Positronium discrimination in liquid scintillators

*Thursday, 11 April 2013 15:00 (1h 20m)*

Electron anti-neutrinos are commonly detected in liquid scintillator experiments via inverse beta decay, by looking at the coincidence between the reaction products, neutron and positron. Prior to positron annihilation, an electron-positron pair may form an orthopositronium (o-Ps) state, with a mean life of a few ns. Even if the o-Ps decay is speeded up by spin flip or pick off effects, it may introduce distortions in the photon emission time distribution, crucial for position reconstruction and pulse shape discrimination algorithms in anti-neutrino experiments. Reversing the problem, the o-Ps induced time distortion represents a new signature for tagging anti-neutrinos in liquid scintillator.

We report the results on the measurement of the o-Ps formation probability and lifetime for the most used solvents for organic liquid scintillators in neutrino physics and for scintillators doped with gadolinium, neodymium, and boron.

**Primary author:** Dr PERASSO, Stefano (APC)

**Presenter:** Dr PERASSO, Stefano (APC)

**Session Classification:** Poster session

**Track Classification:** Cosmogenic activation and low background techniques in experiments

Contribution ID: **61** Type: **oral presentation**

# Evaluation of Ultra-Low Background Materials for U and Th using ICP-MS

*Wednesday, 10 April 2013 15:00 (20 minutes)*

An increasing number of physics experiments require low background materials for their construction. The presence of Uranium and Thorium and their progeny in these materials present a variety of unwanted background sources for these experiments. The sensitivity of the experiments continues to drive the necessary levels of detection ever lower as well. This requirement for greater sensitivity has rendered direct radioassay impractical in many cases requiring large quantities of material, frequently many kilograms, and prolonged counting times, often months. Other assay techniques have been employed such as Neutron Activation Analysis but this requires access to expensive facilities and instrumentation and can be further complicated and delayed by the formation of unwanted radionuclides. Inductively Coupled Plasma Mass Spectrometry (ICP-MS) is a useful tool and recent advancements have increased the sensitivity particularly in the elemental high mass range of U and Th. Unlike direct radioassay, ICP-MS is a destructive technique since it requires the sample to be in liquid form which is aspirated into a high temperature plasma. But it benefits in that it usually requires a very small sample, typically about a gram. Here we will discuss how a variety of low background materials such as copper, polymers, and fused silica are made amenable to ICP-MS assay and how the arduous task of keeping backgrounds of U and Th is achieved.

**Primary author:** HOPPE, Eric (Pacific Northwest National Laboratories)

**Co-authors:** LAFERRIERE, Brian (PNNL); OVERMAN, Nicole (PNNL)

**Presenter:** HOPPE, Eric (Pacific Northwest National Laboratories)

**Session Classification:** Session 3 - Low background counting techniques

**Track Classification:** Low background counting techniques

Contribution ID: **66** Type: **poster**

# Measurement of the neutron yield induced by muons in liquid scintillator and iron at LNGS with the LVD experiment

*Thursday, 11 April 2013 15:00 (1h 20m)*

Fast neutrons from cosmic muons are the ultimate background for any experiments searching for rare events deep underground. The LVD detector, installed at the LNGS, is a multipurpose detector consisting of 1000 t of liquid scintillator and 1000 t of iron.
The main reaction that is detected by LVD is the inverse beta decay which gives two signals: a prompt one due to the e+ followed by the gamma from neutron capture on hydrogen. Thanks to its trigger logic, LVD can is suited to detect both muons and neutrons.
Using the data collected with LVD during 4 years and with the support of a full Monte Carlo simulation, based on Geant4, the neutron yield in liquid scintillator and iron are measured.

**Primary author:** PERSIANI, Rino (BO)

**Presenter:** PERSIANI, Rino (BO)

**Session Classification:** Poster session

**Track Classification:** Background studies, models, and simulations

Contribution ID: **67** Type: **not specified**

# Discussion about LRT2015

*Friday, 12 April 2013 13:10 (15 minutes)*

Contribution ID: **68** Type: **oral presentation**

# Overview of the screening activities with HPGe detectors

*Wednesday, 10 April 2013 09:55 (25 minutes)*

**Primary author:** LAUBENSTEIN, Matthias (INFN - LNGS)

**Presenter:** LAUBENSTEIN, Matthias (INFN - LNGS)

**Session Classification:** Session 2 - Screening facilities and low background detectors

Contribution ID: **69** Type: **oral presentation**

# Overview of wash-off, leaching and surface cleaning techniques

*Wednesday, 10 April 2013 16:00 (25 minutes)*

**Presenter:** Dr CHKVORETS, Oleg (Laurentian University)

**Session Classification:** Session 4 - Fabrication methods and surface contamination control

Contribution ID: **70** Type: **oral presentation**

# Radon assay and purification techniques

*Thursday, 11 April 2013 09:05 (25 minutes)*

**Presenter:** Dr SIMGEN, Hardy (MPIK - Heidelberg)

**Session Classification:** Session 5: Purification/control techniques from radioactive noble gases

Contribution ID: **71** Type: **oral presentation**

# Cosmogenic activation

*Thursday, 11 April 2013 11:20 (25 minutes)*

**Presenter:** Dr CEBRIAN, SUSANA (UNIVERSITY OF ZARAGOZA)

**Session Classification:** Session 6: Cosmogenic activation and low background techniques in experiments

Contribution ID: **72** Type: **oral presentation**

# Crystal scintillators for low background measurements

*Friday, 12 April 2013 09:00 (25 minutes)*

**Presenter:** INCICCHITTI, Maria Antonella (INFN Roma)

**Session Classification:** Session 7: Low background purification and growth techniques for liquids and solids

Contribution ID: **73** Type: **oral presentation**

# Purification of liquid scintillators

*Friday, 12 April 2013 09:25 (25 minutes)*

**Presenter:** Prof. CALAPRICE, Frank (Princeton University)

**Session Classification:** Session 7: Low background purification and growth techniques for liquids and solids

**Track Classification:** Low background purification and growth techniques for liquids and solids

Contribution ID: **74** Type: **oral presentation**

# Purification of KamLAND-Zen liquid scintillator

*Friday, 12 April 2013 09:50 (25 minutes)*

**Presenter:** Dr IKEDA, Haruo (Research Center for Neutrino Science, Tohoku University)

**Session Classification:** Session 7: Low background purification and growth techniques for liquids and solids

Contribution ID: **75** Type: **oral presentation**

# Review of Monte Carlo simulations and muon-induced neutrons

*Friday, 12 April 2013 11:45 (25 minutes)*

**Presenter:** SELVI, Marco (INFN Bologna)

**Session Classification:** Session 8: Background studies, models, and simulations

Contribution ID: **76** Type: **oral presentation**

# Low-level measuring techniques for neutrons: high accuracy neutron source strength determination and fluence rate measurement at an underground laboratory

*Wednesday, 10 April 2013 15:40 (20 minutes)*

We report on low-level measuring techniques for neutrons that have been developed at the Physikalisch-Technische Bundesanstalt (PTB), the German National Metrology Institute. PTB operates well characterized neutron reference fields which are available for experiments and calibration activities and is involved in the development of new detectors and measurement techniques for neutron radiation.

PTB has characterized radioactive sources used in the BOREXINO and XENON100 experiments. For the BOREXINO experiment, a 228Th gamma radiation source was required which would not emit more than 10 neutrons per second. The determination of the neutron emission rate of this specially designed 228Th source was challenging due to the low neutron emission rate and because the ratio of gamma to neutron radiation was expected to be extremely high, of the order of 10^6. For the XENON100 detector, PTB carried out a high accuracy measurement of the neutron emission rate of an AmBe source. The characterization of the source included a systematic check of its flux isotropy.

PTB has also done measurements in underground laboratories. A two month measurement campaign with a set of 3He-filled proportional counters was carried out in PTB's former UDO underground laboratory at the ASSE salt mine (1100 m w.e.). The aim of the campaign was to determine the intrinsic background of detectors, which is needed for the analysis of data taken in low-intensity neutron fields. At a later time, PTB has done preliminary measurements of the neutron fluence rate at the underground laboratory Felsenkeller (110 m w.e.) operated by VKTA. By taking into account data from UDO, Felsenkeller, and detector calibrations made at the PTB facility, it was possible to estimate the neutron fluence rate at the Felsenkeller underground laboratory

**Primary author:** ZIMBAL, Andreas (Physikalisch-Technische Bundesanstalt (PTB))

**Co-authors:** Dr WIEGEL, Burkhard (Physikalisch-Technische Bundesanstalt (PTB)); Dr DEGERING, Detlev (Verein für Kernverfahrenstechnik und Analytik Rossendorf e. V. (VKTA)); SCHUHMACHER, Helmut (Physikalisch-Technische Bundesanstalt (PTB)); Prof. ZUBER, Kai (Technische Universität Dresden); REGINATTO, Marcel (Physikalisch-Technische Bundesanstalt (PTB))

**Presenter:** ZIMBAL, Andreas (Physikalisch-Technische Bundesanstalt (PTB))

**Session Classification:** Session 3 - Low background counting techniques

**Track Classification:** Low background counting techniques

Contribution ID: **77** Type: **oral presentation**

# Measurement and simulation of the muon-induced neutron yield in lead

*Friday, 12 April 2013 12:10 (20 minutes)*

Rare signal searches, such as those performed for direct dark matter detection and neutrinoless double beta decay experiments, are typically carried out in deep underground laboratories, with the consequence that the rock over-burden of such facilities dramatically reduces many of the background signals that would be present if the experiments were conducted in surface laboratories. As improved sensitivity is achieved, the need to characterise and mitigate remaining backgrounds becomes ever more important. One of the most problematic backgrounds that still remains is that of cosmic-ray muon-induced neutrons with the potential of becoming a limiting factor for next generation rare event searches.

A measurement will be presented of the neutron production rate in lead by high-energy cosmic-ray muons of mean energy of 260 GeV at a depth of 2850 m water equivalent. The measurement exploits the delayed coincidences between muons and the radiative capture of induced neutrons in a highly segmented tonne-scale plastic scintillator detector. Detailed Monte Carlo simulations reproduce well the measured capture times and multiplicities and, within the dynamic range of the instrumentation, the spectrum of energy deposits. By comparing measurements with simulations of neutron capture rates a neutron yield in lead has been obtained.

**Primary author:** Ms REICHHART, Lea (University of Edinburgh)

**Co-authors:** CURRIE, Alastair (Imperial College London); BURENKOV, Alexander (Institute for Theoretical and Experimental Physics, Moscow); KOBYAKIN, Alexander (Institute for Theoretical and Experimental Physics, Moscow); MURPHY, Alexander (University of Edinburgh); LINDOTE, Alexandre (LIP-Coimbra & University of Coimbra); KOVALENKO, Alexey (Institute for Theoretical and Experimental Physics, Moscow); HOLLINGSWORTH, Anthony (University of Edinburgh); BEWICK, Arthur (Imperial College London); EDWARDS, Blair (STFC Rutherford Appleton Laboratory); GHAG, Chamkaur (University of Edinburgh); THORNE, Claire (Imperial College London); SILVA, Claudio (LIP-Coimbra & University of Coimbra); AKIMOV, Dimitri (Institute for Theoretical and Experimental Physics, Moscow); BARNES, Emma (University of Edinburgh); NEVES, Francisco (LIP-Coimbra & University of Coimbra); KALMUS, George (STFC Rutherford Appleton Laboratory); ARAÚJO, Henrique (Imperial College London); LOPES, Isabel (LIP-Coimbra & University of Coimbra); QUENBY, John (Imperial College London); PINTO DA CUNHA, Jose (LIP-Coimbra & University of Coimbra); DEVIVEIROS, Luiz (LIP-Coimbra & University of Coimbra); HORN, Markus (Imperial College London); SMITH, Nigel (STFC Rutherford Appleton Laboratory); SCOVELL, Paul (University of Edinburgh); MAJEWSKI, Pawel (STFC Rutherford Appleton Laboratory); WALKER, Richard (Imperial College London); LÜSCHER, Roland (STFC Rutherford Appleton Laboratory); PREECE, Roy (STFC Rutherford Appleton Laboratory); PALING, Sean (STFC Rutherford Appleton Laboratory); PETER, Smith (STFC Rutherford Appleton Laboratory); SUMNER, Tim (Imperial College London); STEKHANOV, Victor (Institute for Theoretical and Experimental Physics, Moscow); FRANCIS, Vishal (STFC Rutherford Appleton Laboratory); CHEPEL, Vitaly (LIP-Coimbra & University of Coimbra); KUDRYAVTSEV, Vitaly (University of Sheffield); BELOV, Vladimir (Institute for Theoretical and Experimental Physics, Moscow); SOLOVOV, Vladimir (LIP-Coimbra & University of Coimbra)

**Presenter:** Ms REICHHART, Lea (University of Edinburgh)

**Session Classification:** Session 8: Background studies, models, and simulations

**Track Classification:** Background studies, models, and simulations

Contribution ID: **78** Type: **oral presentation**

# Review of underground facilities worldwide

*Wednesday, 10 April 2013 09:30 (25 minutes)*

**Presenter:** Dr NOBLE, Tony (Queen's University and SNOLAB)

**Session Classification:** Session 1: Overview of global radioactivity measurement facilities

Contribution ID: **79** Type: **poster**

# Pixel detectors in double beta decay experiments, a new approach for background reduction

*Thursday, 11 April 2013 15:00 (1h 20m)*

Double beta decay experiments are challenging frontiers in contemporary physics. These experiments have the potential to investigate more about neutrinos (eg. nature and mass). The main challenge for these experiments is the reduction of background. The group at IEAP, CTU in Prague is investigating a new approach using pixel detectors Timepix. Pixel detector offer background reduction capabilities with its ability to identify the particle interaction (from the 2D signature it generates). However, use of pixel detectors has some challenges too (e.g. presence of readout electronics near the sensing medium, heat dissipation, etc.). Different aspects of pixel setup (identification of radio-impurities, selection of radio-pure materials) and proposed experimental setup will be presented. Also, results of preliminary background measurements (performed on surface and in the underground laboratories) using the prototype setups will be presented.

**Primary author:** Mr MJOSE, Joshy (Institute of Experimental and Applied Physics, Czech Technical University in Prague)

**Presenter:** Mr MJOSE, Joshy (Institute of Experimental and Applied Physics, Czech Technical University in Prague)

**Session Classification:** Poster session

**Track Classification:** Cosmogenic activation and low background techniques in experiments

Contribution ID: **80** Type: **poster**

# Measurement of very low Rn activities and Rn diffusion in thin foils. Apparatus for measurement of Rn emanation

*Thursday, 11 April 2013 15:00 (1h 20m)*

Group of IEAP CTU in Prague is for a long time involved in radon detection in the frame of SuperNEMO experiment. The sensitive radon detector of hemispherical shape with the volume of 50 litres has been constructed and tested (measurement of efficiency, 30%, and measurement of background, 11±1 events/day in the energy region of 6.2-7.8 MeV peak of 214Po). The detection limit of the apparatus was obtained as 12 mBq/m3 for one day measurement.

Testing device for measurement of radon diffusion through thick shielding foils has been also constructed. Lowest Limit of Detection (LLD) of this device for the radon diffusion coefficient D was obtained at the level ~10-18 m2s-1. Different samples of shielding foils were tested and the obtained results are presented.

To be able to detect low radon activities emanated from material samples, small apparatus with volume of 6 litres has been produced. The apparatus uses again electrostatic collection of radon progenies on Si PIN diode. The background of the emanation device has been measured at the level of 7±1 events/day in the energy region of 6.2-7.8 MeV.

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# Low background HPGe spectrometer in investigations of 2β decay

*Thursday, 11 April 2013 15:00 (1h 20m)*

To search for double beta decay processes to the excited states of daughter nuclei, such as resonant 0νEC/EC decay of 106Cd (TGV experiment) and 2ν2β- decay of 100Mo (NEMO-3 experiment) to the 0+ (1130 keV) and 2+ (540 keV) excited states of 100Ru, a low background HPGe spectrometer Obelix with sensitive volume of 600 cm3 and efficiency of ~160% was installed at the Modane Underground Laboratory (LSM, France, 4800 m w.e.), as a common activity of JINR-IEAP CTU-LSM (details of the spectrometer will be presented by P.Loaiza). Such types of investigations are based on analyzing of γ-rays emitting in de-excitation of the excited states of daughter nuclei. The sensitivity of the Obelix spectrometer for 2β measurements is higher than T1/2 ~10^21 years. To obtain the detector efficiency for such measurements the original method of using special low-active samples with known mass and activity was developed. The samples were produced from the powder of La2O3. The natural La in this powder consists of ~0.09% of 138La (T1/2=1.02×10^11 years), which is characterized by emission of γ-rays with energies of 788.7 keV and 1435.8 keV. Based on the results of measurements of La2O3 and standard sources of 152Eu and 133Ba, efficiency curves for the measurements of double beta emitters were obtained. Metallic foil of enriched 100Mo with a mass of 2517 g was measured with the Obelix spectrometer for 2288 hours. From this measurement the contamination of 100Mo foil (radioactive isotopes and their activities) as well as half-life of 2ν2β- decay of 100Mo to the 0+ and 2+ excited states of 100Ru were obtained. The preliminary results will be presented.

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