DULIA-BIO - Bio Sciences in Deep Underground Laboratories

Report of Contributions

https://indico.stfc.ac.uk/e/DULIA-BIO

Contribution ID: **1** Type: **not specified**

Mine Analogue Research (MINAR). The Boulby Underground Laboratory as a Planetary and Astrobiology Scientific Site and Testbed

Presenter: COCKELL, Charles

Contribution ID: **2** Type: **not specified**

DISCUSSION: Future strategies for Dulia-Bio

Presenter: (ORG COMMITTEE), ALL

Contribution ID: **3** Type: **not specified**

06:00-16:30 - Boulby Underground Laboratory Visit

Thursday, 22 August 2024 06:00 (10 hours)

Max. 20 people (email will be sent to all attendees who have requested visit)
Transport from York to Boulby Underground Laboratory
06:00 pick-up –Hilton Hotel York to Boulby Mine
14.30 pick-up –Boulby to York

Dear All,

We are very much looking forward to welcoming you to Boulby Underground Laboratory on Thursday 22nd August 2024.

Included below is our visit information (an email to those registered for the visit will also be sent), which will give you an idea of timings for visiting Boulby Underground Laboratory.

All visitors are required to be generally physically fit and will need to complete our Pre-visit questionnaire ASAP before visiting, this is a short <10-min online form which gives us essential information to facilitate the visit, the link can be found below:

www.smartsurvey.co.uk/s/BoulbyLab/

The age range for visitor's underground is between 18 and 65, visitors over the age 65 can be accommodated, if that visitor's health is deemed satisfactory, but this will need prior notification to enable us to obtain permission from the mine operator ICL-UK.

There are, however, also certain medical conditions that cannot be accommodated underground:

Unfortunately, we cannot accommodate anyone who is pregnant.

Visitors with a known blood pressure of above 180 systolic or 120 diastolic are not permitted underground. However, if you are currently taking blood pressure medication, and are within the acceptable range, you will be required to have your blood pressure assessed on the day of your visit before you are allowed underground.

All medical conditions are accessed/treated with the highest confidentiality and will only be discussed (if necessary) in private with the onsite Medical Department prior to your visit.

Example of Underground Visit DRAFT Timeline/Schedule below:

Thursday 22nd August
06:00 –Depart York
07:15 –ICL Gatehouse Site Induction
Breakfast (please let us know any special dietary requirements)
Change into PPE ready to go underground (info below)
09:30 - Travel underground for tour of lab facilities and science
13:40 - Ride out, followed by changing back out of PPE.
14:00 –Lunch
14:30 - Visit End (approx.)

PPE will be provided for the underground trip - including high vis clothing, boots, helmet etc. This should all be worn INSTEAD of your normal clothing (i.e. - you just wear underwear underneath).

We recommend wearing/bringing decent socks as we will be providing safety boots. Also, visitors with hair longer than shoulder length will need to tie it back.

Please Note: Mobile Phones are NOT permitted underground under any circumstance.
Laptops, Tablets/iPads etc without cellular connectivity are permitted if required.

If you have any further questions, please get in touch suzanne.armstrong@stfc.ac.uk

Kind regards
Boulby Underground Laboratory

Session Classification: 06:00 - 16:30 - Boulby Underground Laboratory Visit

Contribution ID: **4** Type: **not specified**

Welcome and Context - (in-person)

Monday, 19 August 2024 13:30 (30 minutes)

Presenter: PALING, Sean (STFC)

Session Classification: Welcome and Topic Overviews

Contribution ID: **5** Type: **not specified**

Underground Laboratories: A Brief Review - (in-person)

Monday, 19 August 2024 14:00 (30 minutes)

20-minute talk + 10-minute questions

Presenter: IANNI, Aldo

Session Classification: Welcome and Topic Overviews

Contribution ID: **6** Type: **not specified**

Biology, astrobiology and planetary exploration studies at Boulby Underground Lab - (in-person)

Monday, 19 August 2024 14:30 (30 minutes)

20-minute talk + 10-minute questions

Since 2013, the Boulby Underground Laboratory has been used as a subsurface scientific site to study life in deep subsurface environments and to test equipment for the robotic and human exploration and settlement of space. Over ten subsurface campaigns as part of MINAR (Mine Analogue Research) have been hosted by the laboratory. They have involved teams searching for novel extremophiles in deep subsurface anaerobic brines of relevance to the search for life on Mars and testing rover instrumentation destined for Mars as well as NASA and ESA life detection technology. Planetary scientists from Europe, USA, China, India and other countries, have come to use the underground laboratory to advance space research work. This talk will discuss this work, how underground laboratories can be used for space exploration and settlement, and future prospects for underground laboratories as planetary exploration facilities.

Presenter: COCKELL, Charles

Session Classification: Welcome and Topic Overviews

Contribution ID: **7** Type: **not specified**

Overview of Life in low background radiation studies - (in-person)

Monday, 19 August 2024 15:30 (30 minutes)

20-minute talk + 10-minute questions

Presenter: GARAY, Carlos

Session Classification: Welcome and Topic Overviews

Contribution ID: **8** Type: **not specified**

Beyond Earth Human Habitation Studies Underground - (in-person)

Monday, 19 August 2024 16:00 (30 minutes)

20-minute talk + 10-minute questions

Presenter: IORDACHESCU, Alex

Session Classification: Welcome and Topic Overviews

Contribution ID: **9** Type: **not specified**

Earth/Moon/Mars studies of Extreme Environments - (remote)

Monday, 19 August 2024 16:30 (30 minutes)

20-minute talk + 10-minute questions

EuroMoonMars is an ILEWG/LUNEX programme in collaboration with space agencies, academia, universities and research institutions and industries. The programme includes research activities for data analysis, instruments tests and development, field tests in MoonMars analogue, pilot projects , training and hands-on workshops , and outreach activities. Extreme environments on Earth often provide similar terrain conditions to sites on the Moon and Mars. In order to maximize scientific return it becomes more important to rehearse mission operations in the field and through simulations. EuroMoonMars field campaigns have then been organised in specific locations of technical, scientific and exploration interest. Field tests have been conduct ed in ESTEC, EAC, at Utah MDRS station , Eifel, Rio Tinto, Iceland, La Reunion, LunAres AATC bases in Poland, and at Hawaii.

Latest campaigns have been conducted jointly between EuroMoonMars –International Moon Base Alliance –HI-SEAS (EMMIHS) at Mauna Loa Hawaii since 2018. Samples of different lava flows from Mauna Loa have been compared to measurements of the Mars Exploration Rovers (MER) in order to provide more insight in the similarities of the effects of hydrous alteration on volcanic rocks on Mars. In lava tubes accessible from HI-SEAS, Hawaii, there are several minerals present that appear to form from the surrounding basaltic rock by hydrological and microbial processes. The purpose of this study is to research the secondary mineralization in lava tubes to understand the characteristics and formation processes of the mineral precipitates as analogue for the presence of secondary minerals in lava tubes on other terrestrial bodies in the solar system.

We supported telerobotic campaigns at Etna in 2017 (DLR/ROBEX), and one planned for June 2022 (ARCHES collaboration) and organized EMM-Etna in July 2021.
We performed in 2019-2020 scouting analogue campaigns in Iceland. The EuroMoonMars CHILL-ICE mission in July-August 2021, was set in the Surtshellir-Stefanshellir cave system in the Hallmundarhraun lava flow located in Western Iceland. We tested instruments and equipment (rovers, drones) in a lunar- analogue field terrain. 2x3 astronauts in EVA deployed ECHO emergency shelter in a lavatube where they stayed for 2x3 days.

In Chile, the Atacama Desert and the neighboring Arid Central Andes (Puna) represent a geographical site whose particular environmental conditions make it a potential Mars analogue. A scout Chile MoonMars campaign was organized in February 2021, and a large Atacama Ojos del Salado campaign was conducted 21 Feb-6 March 2022.

Presenter: FOING, Bernard

Session Classification: Welcome and Topic Overviews

Contribution ID: **10** Type: **not specified**

SNOLAB: Underground Facilities for Biological Experiments - (in-person)

Tuesday, 20 August 2024 09:00 (30 minutes)

20-minute talk + 10-minute questions

SNOLAB, with its underground facilities at 2070 m within Creighton Mine in Sudbury, Ontario, Canada, has already hosted biological experiments, including FlaME and REPAIR, providing a unique environment for experiments requiring isolation from surface background radiation. Improvements at SNOLAB, including the introduction of local ICP-MS analysis for metal content, underground liquid nitrogen production, UPW upgrades, and many more have increased the overall capabilities of SNOLAB to host new experiments considerably. Presented will be an overview of the facilities and improvements in bio-assay techniques available.

Presenter: HALL, Shaun

Session Classification: Underground Labs Science Programmes

Contribution ID: **11** Type: **not specified**

Biosciences at Callio Lab - (in-person)

Tuesday, 20 August 2024 09:30 (30 minutes)

20-minute talk + 10-minute questions

Callio Lab is one of the northernmost deep underground laboratories and research environments in Europe. It is located at the Pyhäsalmi mine, Finland. The early focus of the laboratory has been underground physics, but since 2015, it has been open for trans- and multidisciplinary research and art. Pilot projects with underground farming, including plant and insect-based, and with the discovery of the life within deep underground saline water pockets - life in extreme - create unique possibilities for future research and cooperation. In the talk, a summary of activities and research possibilities will be given.

Presenter: JOUTSENVAARA, Jari

Session Classification: Underground Labs Science Programmes

Contribution ID: **12** Type: **not specified**

Prospects of Bio Science Research in Deep Underground Laboratories in Africa: Botswana Perspective - (in-person)

Tuesday, 20 August 2024 10:00 (30 minutes)

20-minute talk + 10-minute questions

There is currently no Deep Underground Laboratory in Africa despite the research challenges Africa faces in Bio Science, some of these research challenges can be addressed partly through the existence and utilization of Deep Underground Laboratories. There is however one envisaged project to construct a Deep underground laboratory in South Africa, named Paarl Africa Underground Laboratory (PAUL), this project is already at construction stage and will be the first in Africa and the second in the southern hemisphere. Botswana like the rest of the world need a Deep Underground Laboratory. The country established, Botswana International University of Science and Technology (BIUST) as a science and technology dedicated University, with a vast campus of about 2000 hectares. The size of the campus provides ample space for the establishment of a Deep Underground Laboratory. Considering the extreme exposure of the terrestrial environment to the sun. Natural radiation is anticipated to be high due to clear skies with no cloud cover most of the year. It will be most ideal to conduct radiobiology experiments in deep underground laboratories to study both in vitro and in vivo biological systems. These in vitro and in vivo experiments can help build new insights in research activities around diseases over burdening the Botswana economy e.g HIV/AIDS, cancer, diabetes mellites and antibiotic resistance. Establishment of these laboratories at BIUST or collaborations with existing facilities elsewhere will help scientist at BIUST study possible influences of natural radiation on disease progression and/or disease treatment. Humanised mice model for HIV/AIDS, cancer and diabetes mellites can be observed both under natural radiation and in Deep underground laboratories to study disease progression at molecular level. Influences of natural radiation on antibiotic resistance can also be elucidated during exposure of treatment models to natural radiation or when excluded in Deep Underground laboratory. These findings can inform on the ameliorative measures to be put in place by the country.

Presenter: KWAPE, Tebogo

Session Classification: Underground Labs Science Programmes

Contribution ID: **13** Type: **not specified**

The REPAIR project: investigating the effects of sub-natural background radiation exposure within SNOLAB - (in-person)

Tuesday, 20 August 2024 11:00 (30 minutes)

20-minute talk + 10-minute questions

Living systems are continually exposed to background ionizing radiation and have evolved and adapted in its presence. However, the potential biological impacts of this chronic low dose rate exposure remain poorly understood. The REPAIR (Researching the Effects of the Presence and Absence of Ionizing Radiation) project, located at SNOLAB in Sudbury, Ontario, Canada, is investigating the biological effects of sub-natural background radiation exposure. This talk will provide an overview of the current results and future experimental goals of REPAIR. To date, experiments have been conducted with various model systems including human cell culture, yeast, C. elegans, and lake whitefish embryos. A custom designed tissue culture glovebox was constructed to control radon gas and gamma radiation in the underground laboratory, providing an environmental dose rate of 2.5 nGy/hr, approximately 30-fold lower than on surface. A further significant reduction in experimental dose rate has recently been achieved through removal of endogenous potassium-40 from culture media. Overall, these ongoing experiments in SNOLAB will contribute to the wider underground scientific community in hopes of elucidating the biological role of natural background ionizing radiation.

Presenter: THOME, Chris

Session Classification: Studies of Life in Low Background Radiation

Contribution ID: **14** Type: **not specified**

Adaptive and evolutionary responses of microalgae to ultra-low radioactivity at the Modane Underground Laboratory - (in-person)

Tuesday, 20 August 2024 11:30 (30 minutes)

20-minute talk + 10-minute questions

Our knowledge is limited on the long-term impact of natural radioactivity on living organisms, particularly those inhabiting aquatic ecosystems. Living organisms have developed resistance to ionizing radiation, but it remains to be determined whether they have fully adapted to this radiation or whether they continue to be influenced by this stress. Biological experiments conducted on bacterial populations in underground laboratories have shown that reduced radiation levels lead to various physiological consequences, such as growth inhibition and increased sensitivity to chemical mutagens. The RAMURe project at LSM studies the response of three species of diatoms, sentinels of the environment, to ultra-low radioactivity: 1) Planothidium frequentissimum, present in radioactive mineral sources in Auvergne; 2) Phaeodactylum tricornutum, a marine diatom widely used as a model to study the response to stress; 3) Achnanthidium saprophilum, living in lakes, used for radiochemistry studies on the fixation of radioelements. The project focuses on the ability of diatoms to adapt to radioactive stress, measuring parameters such as growth rate, size, volume, photosynthetic capacity, pigment and lipid content, as well as oxidative stresses. and antioxidants.

Presenter: BRETON, Vincent

Session Classification: Studies of Life in Low Background Radiation

Contribution ID: **15** Type: **not specified**

Effects of microgravity and below-background radiation in the pathogenesis of Orsay virus infection of Caenorhabditis elegans - (remote)

Tuesday, 20 August 2024 12:00 (30 minutes)

20-minute talk + 10-minute questions

In the near future, space missions will be extended to meet exploration goals. Space conditions, particularly microgravity and radiation, present unique stresses for organisms that they have not evolved to handle. The impact of these conditions on viral infections and host antiviral defenses is not well understood. C. elegans, a model organism, and its natural virus, Orsay virus (OrV), were used to study these interactions. The study examined the viral load during C. elegans' larval development under simulated microgravity using a random position machine and below-background radiation conditions at LSC. Our findings revealed changes in the viral load and effects on C. elegans' fitness traits in the three conditions: microgravity, below-background radiation, and both combined. Transcriptome analyses of infected worms in these conditions are underway to further understand these stresses and their impact on the host. Overall, the data indicate that space conditions can influence viral infections, which is a significant discovery for future space missions.

Presenter: ELENA, Santiago

Session Classification: Studies of Life in Low Background Radiation

Contribution ID: **16** Type: **not specified**

Tracking ancient and modern microbial life in salt and brines of Boulby Mine (N Yorkshire) or: What to look out for on Mars - (in-person)

Tuesday, 20 August 2024 13:30 (30 minutes)

20-minute talk + 10-minute questions

Our study aims to produce a biogeochemical fingerprint of fossil and living microbial organisms in salt and brines of the mine at Boulby by analysing lipid biomarkers (alkyl lipids, GDGTs) and DNA. Outcomes are expected to contribute insights into late Permian hydrology and paleoecology, extremophile ecology and astrobiology. Biomarker distributions in the salt and, in particular, in backfilled desiccation cracks can provide information on the environmental conditions in and around the Zechstein Sea ~250 million years ago. The site represents a shallow proximal setting of the Zechstein Basin, with exposure of the evaporite surfaces during sea-level lowstand. We can confirm earlier observations of microbial biomarkers, mainly short-chain n-alkanes with a very low odd-over even predominance. In addition, we have found traces of leaf wax-derived mid-chain (C22-C26) fatty acids, representing input from the nearby coast. Short-chain mono-unsaturated C18 fatty acids most likely represent contamination from modern bacteria. Further analyses to confirm their origin are currently in progress. The biomarker data will help to interpret Raman spectroscopy data produced from the same material. Raman spectroscopy will be one of the tools aboard the next generation Mars rovers. Marsian evaporites are prime targets in the search for extra-terrestrial life since the last places where microbial life could have existed on Mars would have been the evaporating oceans. Finally, identifying and fingerprinting microbes living in modern brines of the mine and on tunnel walls will both help to understand community adaptation to variable ion distributions and provide a control to detect contamination of the fossil material.

Presenter: HOLTVOETH, Jens

Session Classification: Deep Underground Microbiology Research

Contribution ID: **17** Type: **not specified**

Biological habitats in the Subsurface - (remote)

Tuesday, 20 August 2024 14:00 (30 minutes)

20-minute talk + 10-minute questions

Presenter: PERL, Scott

Session Classification: Deep Underground Microbiology Research

Contribution ID: **18** Type: **not specified**

Biophysical and microbiological research at the deep underground low radiation background laboratory (DULB-4900) and tunnel of Baksan Neutrino Observatory - (remote)

Tuesday, 20 August 2024 14:30 (30 minutes)

20-minute talk + 10-minute questions

Deep underground laboratories at physical research centers possess an outstanding potential for hosting biological experiments in fields of biophysics, radiobiology, astrobiology, microbiology and medicine. Molecular genetics group of DLNP JINR initiated cooperative studies in the deep underground low radiation background laboratory (DULB-4900) and horizontal tunnel of Baksan Neutrino Observatory (BNO INR RAS), located ~2.5 km beneath the peak of Andyrchy mountain (3937 m) and 25 km away from Elbrus mountain (North Caucasus, Russia). Initial biological experiments were performed in 2019 and aimed to register for the first time the response of complex model organism (Drosophila melanogaster) to the low background radiation by transciptomic technique and to analyze the obtained results in terms of the impact of different types of stress through comparative transcriptome analysis. The list of 77 differentially expressed genes in D. melanogaster exposed to low radiation background in DULB-4900 (~16 nGy h-1) relatively to the natural radiation background at the surface building (~190 nGy h-1) was obtained. In DULB-4900, up-regulation of genes related to immune response, response to stimuli and down-regulation of genes involved in primary metabolic processes were observed. Changes in gene expression reflect an adaptive response to DULB-4900 conditions that are stressful and not typical for terrestrial organisms, possibly due to the chronic lack of external natural stimuli. Next, the biological impact of the cosmic component of natural background radiation will be studied through the focus on high energy muons (>1 GeV). On that goal combined experiments at DULB-4900, enabling nearly complete shielding of muons, and at muon beam of accelerator facility U-70 (IHEP, Protvino) are conducted. The locations of Baksan Neutrino Observatory and especially far unused parts of the 4.5-km-length tunnel located 2.5 km deep underground are highly perspective for the research of deep underground organisms and extremophiles. This is one of the deepest easily-accessible locations in North Caucasus and Russia and, notably, it is in proximity to dormant Elbrus volcano . Our group managed to discover and perform metagenomic analysis of the biofilm community inhabiting deep underground mineral spring in granitic rock. The study was accomplished by the cultivation of some microorganisms and have already lead to the discovery of several novel genera and species of bacteria. To sum up, the exploration of unique microbial communities in Baksan Neutrino Observatory reveals deepest microbiomes ever studied in North Caucasus and Russia, which will contribute to the knowledge on the global distribution of deep underground biosphere.

Presenter: ZARUBIN, Mikhail

Session Classification: Deep Underground Microbiology Research

Contribution ID: **19** Type: **not specified**

Investigating the effect of low background radiation in the origin of animals - (remote)

Tuesday, 20 August 2024 16:00 (30 minutes)

20-minute talk + 10-minute questions

Background radiation is an abiotic component of Earth's surface environment that has potentially influenced biophysical and biochemical processes throughout evolution. One of the most critical evolutionary transitions was the emergence of multicellularity in animals, which led to the vast diversity observed in animals today. By studying the unicellular relatives of animals, we can gain valuable insights into this transition. To investigate how background radiation may have influenced the origin of multicellularity in animals, we designed an experimental evolution project at the Canfranc Underground Lab. This experiment involves exposing two species of unicellular animal relatives, Capsaspora owczarzaki and Sphaeroforma arctica, to low background radiation for six months. We will monitor the organisms' growth kinetics, assess changes in gene expression using transcriptomics, and sequence their genomes to identify any emerging mutations. This study aims to elucidate the potential role of background radiation in the evolution of multicellularity, providing new perspectives on the evolutionary processes that shaped early animal life. Additionally, by studying these two species, we will double the number of eukaryotic lineages in which background radiation has been studied.

Presenter: SUÁREZ ARA, Patricia

Session Classification: Studies of Life in Low Background Radiation

Contribution ID: **20** Type: **not specified**

DISCOVER22 radiobiology project at Gran Sasso National Laboratory - (remote)

Tuesday, 20 August 2024 16:30 (30 minutes)

20-minute talk + 10-minute questions

Patrizia Morciano1,2; Matthias Laubenstein1; Valentina Dini3,4; Giorgio Baiocco5,6; Valeria Conte7; Antonella Sgura8,9 1INFN-Laboratori Nazionalli del Gran Sassso, Assegi L'Aquila, Italy 2Università degli Studi dell'Aquila, Dipartimento di Medicina clinica, sanità pubblica, scienze della vita e dell'ambiente, L'Aquila, Italy 3 Centro Nazionale di Tecnologie Innovative in Sanità Pubblica, Istituto Superiore di Sanità, Rome, Italy 4INFN-Roma1, Rome, Italy 5Dipartimento di Fisica, Università degli Studi di Pavia, Pavia, Italy, 6INFN-Pavia, Pavia, Italy, 7INFN-Laboratori Nazionali di Legnaro, Padova, Italy, 8Dipartimento di Scienze, Università degli Studi Roma Tre, Rome, Italy, 9INFN-Roma3, Rome, Italy Deep Underground Laboratories (DULs) offer a unique space and appropriate facilities for underground radiobiology studies that aim to investigate the role of natural environmental radiation in the metabolism of living organisms. To date many different studies have supported the hypothesis that natural background radiation plays a role in maintaining homeostasis and proper capabilities to respond to additional stress in different organisms. Recently, we started DISCOVER22 (DNA Damage and Immune System Cooperation in VEry low Radiation environment 2022) project supported by INFN-CSN5 at Laboratori Nazionali del Gran Sasso (Italy). DISCOVER22's main purpose is to investigate the modulation of the immune response in a below background radiation environment. To our knowledge, this aspect has not so far been systematically studied under these conditions. DISCOVER22 experiment aims to investigate how the Low Radiation Environment (LRE) modulates the immune system response with in vitro and in vivo models. For in vitro experiments two different human cell lines are employed, human keratinocytes HaCaT and human promyeloblast leukemia HL60 cells. Specifically, HaCaT were cultured in parallel in LRE and in Reference Radiation Environment (RRE) to evaluate the activation of the cGAS/STING pathway following radiation-induced DNA damage. Preliminary results suggest a down-regulation of the innate immune system response in LRE HaCaT cells. In HL60 cells the ability of immature immune cells both to differentiate into macrophages and neutrophils and to maintain their biological functions after exposure to LRE have been investigated. A preliminary different modulation of specific membrane antigens (CDs) has been found in LRE cells compared to RRE cells confirming a different cellular response in the two exposure environments that need further investigation. Finally for in vivo experiments in Drosophila, a RNASeq analysis showed a down regulation of biological processes involved in the innate immune response in LRE flies. All together these preliminary results suggest that environmental radiation is an essential factor for proper immune response in cells as well as in flies.

Presenter: MORCIANO, Patrizia

Session Classification: Studies of Life in Low Background Radiation

Contribution ID: **21** Type: **not specified**

Microdosimetry of low dose radiation fields in the framework of the DISCOVER22 project - (remote)

Tuesday, 20 August 2024 17:00 (30 minutes)

20-minute talk + 10-minute questions

While high doses of ionizing radiation are known to harm human health, the effects of low dose radiation (LDR) are debated. LDR has been shown to influence immune responses, possibly inducing beneficial effects, but the underlying mechanisms are not well understood. Research on LDR effects is often affected by uncertainties like unmonitored radiation quality and uncontrolled physical variables. The Gran Sasso Laboratories of the Italian National Institute of Nuclear Physics (INFN-LNGS) provide a unique environment for studying LDR's effects, with significantly reduced cosmic ray and neutron exposure. In these labs, the gamma dose rate is about 20-25 nGy/h, resulting in a weekly total of approximately 4 µGy. At such low doses, radiation interaction is highly stochastic, making absorbed dose alone an insufficient measure. To improve the correlation between biological responses and radiation exposure, we will use microdosimetric techniques to monitor the energy deposition and LET distribution continuously. A specialized tissue equivalent proportional counter (TEPC), simulating 1-2 µm of biological tissue, will be employed to capture detailed microdosimetric spectra. This TEPC, designed by INFN, can detect around 30,000 events daily, providing robust data to characterize indoor and outdoor radiation environments. Initial findings from these measurements will be presented and analyzed.

Presenter: BIANCHI, Anna

Session Classification: Studies of Life in Low Background Radiation

Contribution ID: **22** Type: **not specified**

The Effect of Natural Background Radiation on Stem Cell Biology - (in-person)

Wednesday, 21 August 2024 09:00 (30 minutes)

20-minute talk + 10-minute questions

A number of experiments have shown that cells grown under chronic and/or acute low doses of radiation exhibit growth and fitness traits different from cells grown at control radiation levels, suggesting a radioadaptive response. Adult stem cells are a rare population of undifferentiated cells located within a differentiated organ or tissue, in a specialized structure called a niche. These niches maintain the local microenvironments that regulate the growth and development of stem cells. Adult stem cells have the capacity to self-renew and can differentiate into a limited number of mature cell types. The main role of adult stem cells is to maintain tissue homeostasis. These cells are normally maintained in a quiescent state but can be activated to proliferate and differentiate into the required cell types upon the loss of cells or injury to the tissue. Adult stem cells have been identified in many tissues, including bone marrow, intestine, skin, muscle, brain, and heart. Due to their long lifespan, adult stem cells may sustain several rounds of radiation damage that, individually, may not have a significant impact on cellular physiology. However, collectively, these rounds of radiation damage may severely affect cellular function. Following damage, cells may properly repair DNA and re-establish functionality, but if DNA damage is extensive, cells may accumulate irreversible damage that triggers either apoptosis or senescence. Senescence is a process that induces permanent cell cycle arrest with a loss of cellular functions and may produce various biological outcomes. The senescence of stem cells could be very deleterious as it can greatly impair tissue homeostasis and repair. Alternatively, cells with unrepaired damage may sustain mutations and undergo malignant transformation. Given that humans are constantly exposed to low-dose radiation (IR) in the environment from natural backgrounds, the effect induced by IR on the biology of adult stem cells could have deleterious consequences for the whole organism. Despite the significant attention the scientific community has bestowed upon adult stem cells, little is known about the effects of low-dose IR on tissue stem cells. On these premises, we aim to investigate the effect of natural background radiation on key aspects of stem cell biology (i.e., DNA repair capacity and senescence). Our intention is to perform experiments on a specific kind of adult stem cell, namely mesenchymal stromal/stem cells (MSCs). This choice is due to the following reasons: MSCs, present in most stromal tissues, are a heterogeneous population containing multipotent stem cells, progenitors, and differentiated cells. MSCs can differentiate into mesodermal progeny, such as osteocytes, chondrocytes, adipocytes, and muscle cells. In the human body, the impairment of MSC activities has huge repercussions on health, given their key role in tissue and organ homeostasis. These properties have also been exploited in MSC-based cell therapy.

Presenter: GALDERISI, Umberto

Session Classification: Studies of Life in Low Background Radiation

Contribution ID: **23** Type: **not specified**

Stem cells long term preservation - (remote)

Wednesday, 21 August 2024 09:30 (30 minutes)

20-minute talk + 10-minute questions

Presenter: WAROT, Guillaume

Session Classification: Studies of Life in Low Background Radiation

Contribution ID: **24** Type: **not specified**

Does ionizing radiation affect HIV release from human macrophages? - (remote)

Wednesday, 21 August 2024 10:00 (30 minutes)

20-minute talk + 10-minute questions

Viruses have small genomes that encode a few proteins required for their propagation. To complete their replication cycles, viruses usurp host cell machineries. By studying virus replication, we gain insights into the biology of host cells and organisms. A classic example is the human immunodeficiency virus (HIV), the most studied virus. HIV affects host cells and progressively compromises the immune system, with the eventual development of AIDS in the absence of antiretroviral therapy (ART). ART suppresses virus replication, resulting in chronic and asymptomatic infection. During chronic infection, viral reservoirs persist, and that can cause viral load to rebound if treatment is interrupted or when drug resistance develops. Notably, some HIV-positive individuals may be exposed to low background radiation (LBR). However, studies have shown that LBR can shape the immune system, and it is not entirely clear how LBR may affect HIV infection prognosis and treatment. Changes in the morphology of subcellular structures have been reported in uninfected cells exposed to LBR. Although essential, studies on HIV replication in low radioactive environments such as underground laboratory conditions are lacking. The development of a new underground laboratory in South Africa, the Paarl Africa Underground Laboratory (PAUL), will provide a conducive environment to undertake such functional biological studies. PAUL is the first on the African continent and will be an excellent resource for biomedical research in Africa, especially the Sub-Saharan Africa, that has the highest global burden of infectious diseases.

Presenter: NKWE, David

Session Classification: Studies of Life in Low Background Radiation

Contribution ID: **25** Type: **not specified**

Opportunities and challenges of deep underground science facilities and research laboratories: An extended review of current status - (in-person)

Wednesday, 21 August 2024 11:00 (30 minutes)

20-minute talk + 10-minute questions

Deep underground science facilities and research laboratories have the potential to provide a sustainable outlet for the disposal of radioactive waste. These deep underground science facilities and research laboratories can also be used to train qualified personnel. Working underground affords a highly controlled and stable environment for research and experimental purposes. Research activities undertaken in these underground facilities are protected from varying environmental conditions such as air quality and sudden and unanticipated weather changes. Perhaps more importantly, underground laboratories can be utilized in different fields of research such as physics (e.g. nuclear physics), geology (e.g. geochemistry), agriculture (e.g. food production) and biology (e.g. microbiology). Unfortunately, however, the development of deep underground science facilities and research laboratories is very costly. For example, in Africa, South Africa specifically, the development of the first underground laboratory in Africa is expected to commence sometime this year. Based on the above, this presentation will elucidate some of the benefits and novel opportunities that have come along due to the emergence of deep underground science facilities and laboratories. These benefits will be exploited from different angles such as economical gains, food sustenance and security, employment opportunities, educational development and others. However, issues of development costs for these research laboratories and the solicitation of trained personal remain big challenges to the full-scale growth of these facilities. Other challenges remain detrimental as well. This presentation will, therefore, additionally look at ways of alleviating and mitigating challenges that affect the development and use of deep underground science facilities and research laboratories, especially in third world countries and developing nations.

Presenter: GAOBOTSE, Goabaone

Session Classification: Underground Labs Science Programmes

Contribution ID: **26** Type: **not specified**

Bioscience and Beyond Outreach at Boulby - (in-person)

Wednesday, 21 August 2024 11:30 (30 minutes)

20-minute talk + 10-minute questions

Presenter: GUTTERIDGE, Jonathan (STFC)

Session Classification: Underground Labs Science Programmes

Contribution ID: **27** Type: **not specified**

DISCUSSION: Reproducibility and networking for future underground bio-sciences - (in-person)

Wednesday, 21 August 2024 13:00 (45 minutes)

Presenters: GARAY, Carlos; COCKELL, Charles

Session Classification: Discussion and Future Planning

Contribution ID: **28** Type: **not specified**

DISCUSSION: Specifications and requirements for a future underground bio-sciences lab

Wednesday, 21 August 2024 14:45 (45 minutes)

Presenters: MEEHAN, Emma (STFC); SCOVELL, Paul (STFC); PALING, Sean (STFC)

Session Classification: Discussion and Future Planning

Contribution ID: **29** Type: **not specified**

DISCUSSION: Future of bioscience research and the role of underground laboratories

Presenter: ALL (ORGANISING COMMITTEE)

Session Classification: Discussion and Future Planning

Contribution ID: **30** Type: **not specified**

Bioscience at SURF - (remote)

Monday, 19 August 2024 17:00 (30 minutes)

20-minute talk + 10-minute questions

The Sanford Underground Research Facility (SURF) with its vast underground footprint provides opportunities for research activities beyond astroparticle physics, rare event searches and neutrino physics. SURF is hosting biology research focusing on microorganisms in extreme environments, biofilms, as wells as astrobiology and in-situ cultivation. A brief overview of the research currently performed at SURF will be presented. The facility's unique characteristics present a number of opportunities, and applications from new experiments and groups are welcome.

Presenter: HORN, Marcus

Session Classification: Welcome and Topic Overviews

Contribution ID: **31** Type: **not specified**

How statistical physics limits microbial life under extreme conditions: foraging and motility

Tuesday, 20 August 2024 15:00 (30 minutes)

20-minute talk + 10-minute questions

The ability of cells to move - their motility - is important across a very wide range of species from eukaryotes, bacteria and archaea. Although their motility structures (such as cilia and flagella) evolved from different precursor organelles, the physical laws that constrain their performance are the same. Archaea in the deep subsurface environment offer the perfect test-bed for these ideas, at the low-energy limit. The extremophile halophilic archaea from Boulby Mine move slowly but deliberately, and are capable of sensing and responding to chemical gradients. By studying the swimming behaviour of archaea in 3D using digital holographic microscopy, we explore the limits at which microbial motility confers a selective advantage on cellular length and time scales.

Presenter: WILSON, Laurence

Session Classification: Deep Underground Microbiology Research

Contribution ID: **32** Type: **not specified**

DISCUSSION: Future of bioscience research and the role of underground laboratories

Wednesday, 21 August 2024 13:45 (45 minutes)

Presenter: ALL (ORGANISING COMMITTEE)

Session Classification: Discussion and Future Planning