

Radiopurity Service at Laboratorio Subterráneo de Canfranc (LSC)



Iulian Bandac

OUTLINE

- Hall C.
- Detectors characteristics.
- MC simulations.
- New shields.
- Material screening.
- Neutron background measurements.
- Clover measurement Hall A.
- Radon monitoring.
- Temperature and pressure monitoring.
- Radioactive measurements with TLD dosimeters.
- Water quality indicators.
- To do.

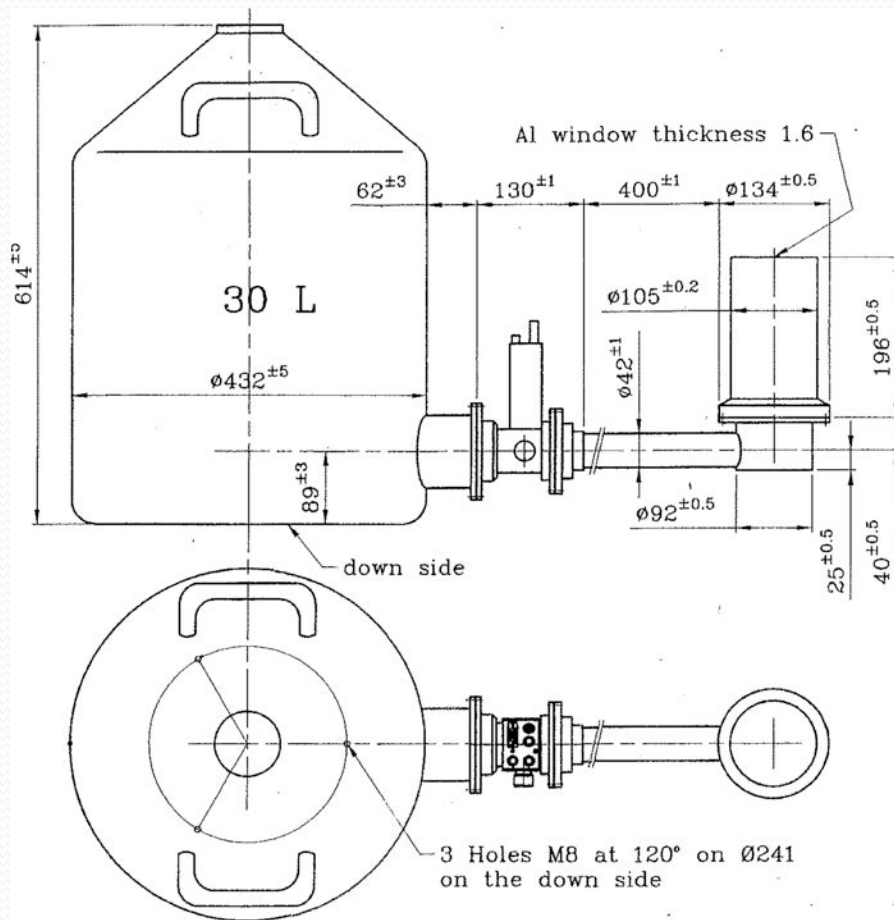
Hall C



Hall C

- 5 LSC detectors, 4 mounted and taking data, 1 to be mounted in the first trimester of 2013:
 - GeOroel (54181), GeTobazo (54213), GeAnayet (54214), GeLatuca (54262) - mounted
 - GeAspe (54261) – to be mounted
- 2 detectors University of Zaragoza, one mounted and taking data, 1 to be mounted in January-February 2013.
 - Ge7074 - mounted
 - Ge7084 - to be mounted

Detectors Characteristics



Detectors Characteristics

serial number	delivery	diameter in mm	length in mm	weight in g	relative efficiency in %
54181	Apr-10	81,4	81,7	2230	109
54213	Dec-10	81,2	81,2	2185	110
54214	Dec-10	81,0	81,1	2183	109
54261	Nov-11	81,0	81,2	2187	108
54262	Nov-11	81,0	81,2	2187	108

Measurement conditions:

shaping time: as indicated on the specification sheet

count rate: 1000cps

with analogue setup: CANBERRA 2026 amplifier and multiportII

Point source of ^{60}Co

Electronics

Preamplifier: PSC761 Canberra.

DSA 1000 (Digital Spectral Analyzer) from Canberra.

- Very stable.
- All in one, small dimensions.
- Easy to control, using Genie2000 software from Canberra. Ideal for remote management of the detectors.



Detectors Characteristics

Shielding:

20 cm of lead (480 bricks),

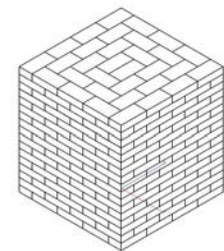
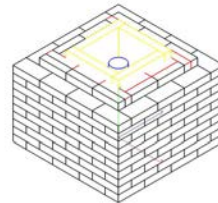
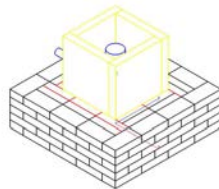
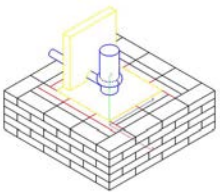
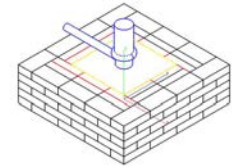
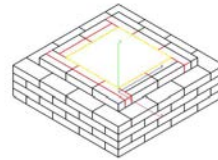
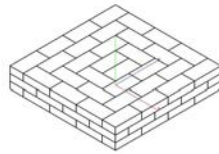
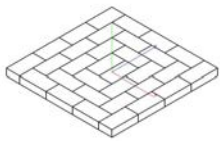
5 cm Cu-OF rolled,

Methacrylate Rn shield (1 cm).



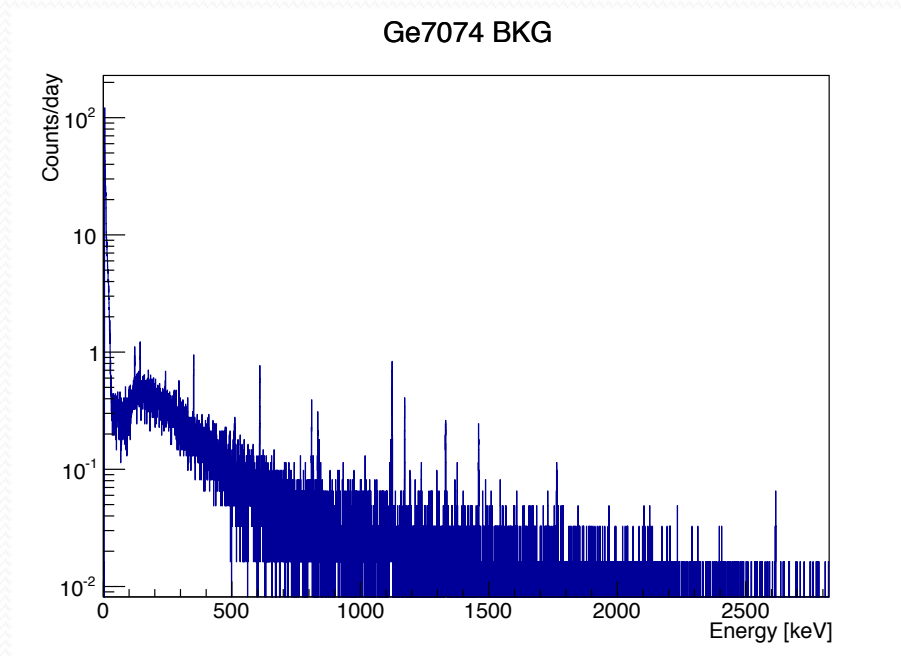
Underground Synergies 2012 Durham, UK

Detectors Characteristics



20 cm Pb
5 cm Cu-OF, rolled

Detectors Characteristics



Rate[100-2700 keV] = 5.4 mHz

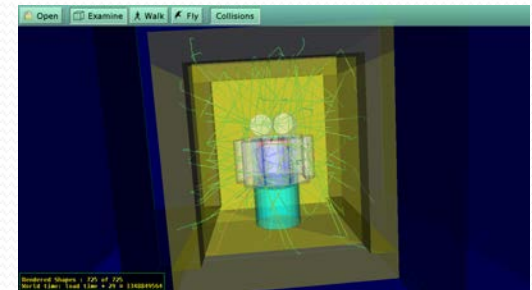
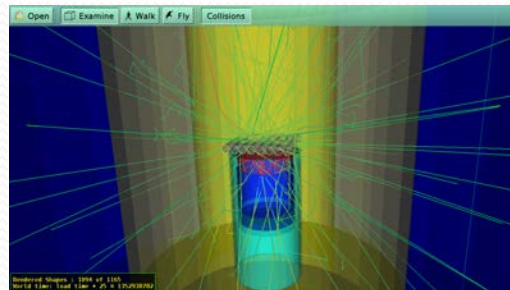
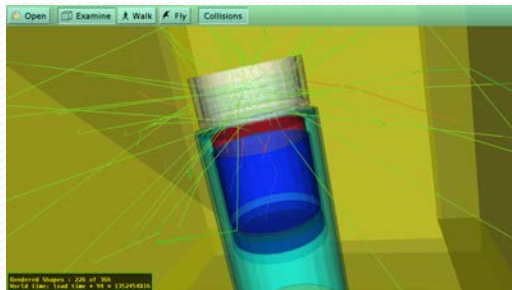
Rate[609 keV] = 1.2 mHz

Rate[50-583 keV] = 4.6 mHz

Monte Carlo Simulations

A MC simulation program, GEBIC, was developed using Geant4. GEBIC was improved and tested in collaboration with University of Zaragoza. GEBIC is used to calculate detector efficiency for each sample.

Code slightly modified to include specific characteristics of each detector.

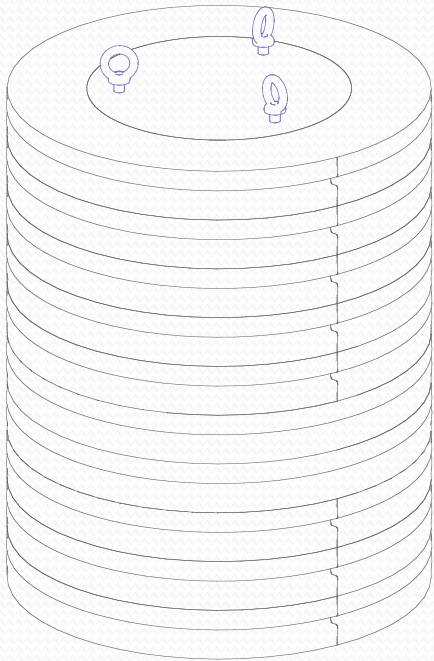


Understand better detectors background, modify the cleaning protocol of the shield materials and the shield structure to eliminate it as much as is possible.

New Shields

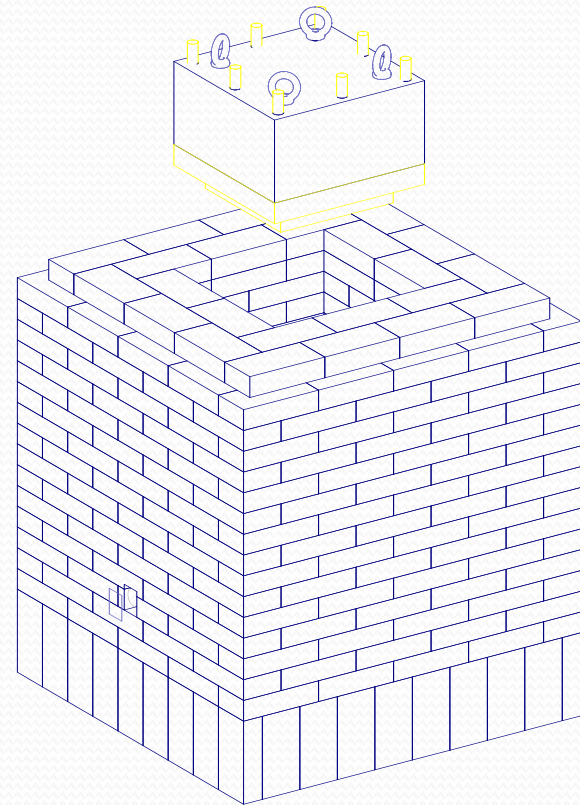
20 cm Pb

5 cm Cu-OF, rolled



20 cm Pb = 660 Pb bricks

10 cm Cu-OF, rolled

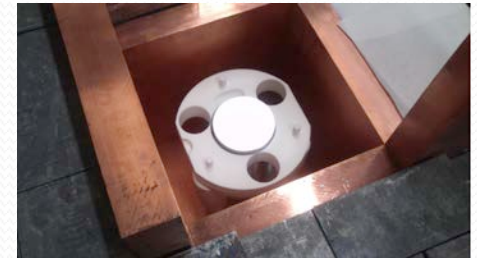


Material Screening

Material screening for experiments: NEXT, SUPERKGD, ArDM, ANAIS and BiPo with 5 HpGe.

Results from the measurements done for NEXT to be published soon in JINST.

arXiv: 1211.3961



Neutron Background Measurement

Measurements done in collaboration with CUNA. Results to be published soon in Astroparticle Physics Journal.

- 1) Direct measurement of the neutron bkg. Level and energy distribution using Bonner Sphere Spectrometers (BSS).
 - cylindrical ^3He proportional counter ($\Phi = 9 \text{ mm}$, $h = 10 \text{ mm}$)
 - HDPE spheres with diameters: 2.5", 3", 4.2", 5", 6", 8", 10" and 12".

Detector #	PE matrix size (cm ³)
1	4.5×4.5×70.0
2	7.0×7.0×70.0
3	12.0×12.0×70.0
4	18.0×18.0×70.0
5	22.5×22.5×70.0
6	27.0×27.0×70.0



- 2) 6 large ^3He proportional counters ($\Phi = 2.54 \text{ cm}$, $h = 60 \text{ cm}$), filled at 20 atm. Detectors and data acquisition from BELEN detector.

HDPE matrices with different sizes (table).

Calibration ^{252}Cf (400 n/s) source.
Measurement 26 days.

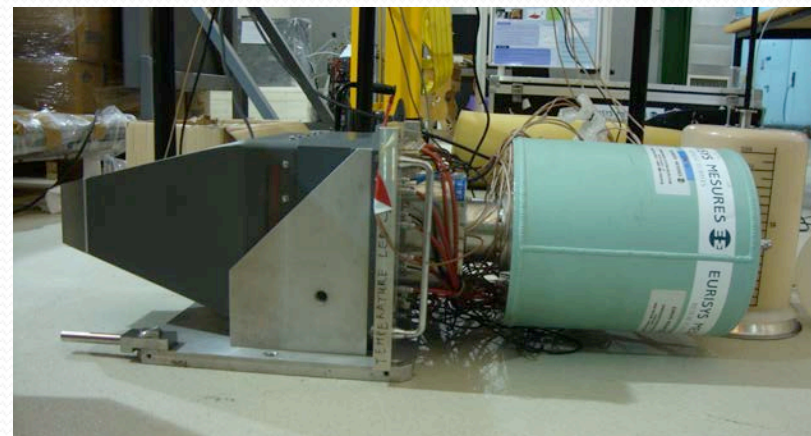


Clover Measurement in Hall A

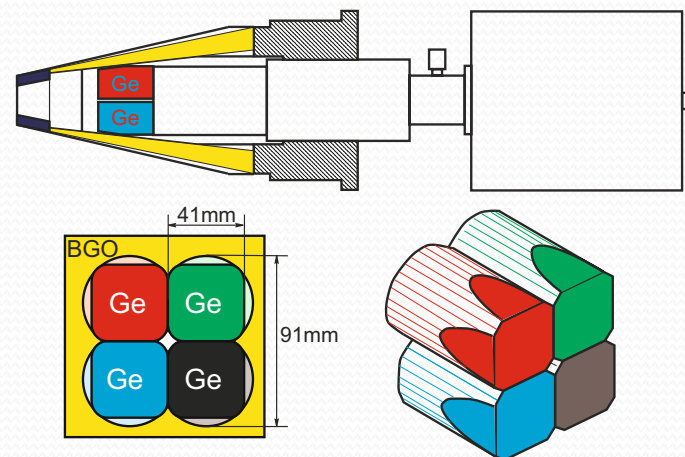
The laboratory γ -ray background in Hall A was measured in the period 18 -26 October 2012 with a Clover detector from ATOMIKI Debrecen, Hungary, in collaboration with CUNA collaboration.

Spectra have been recorded both for the single segments and for the virtual detector formed by online addition of all four segments.

The signals from the four crystals are split after the preamplifiers. One part is fed into four main amplifiers, and the signals are then digitized and recorded in self-triggered, histogramming mode. These four individual histograms are then gain-matched and added channel by channel, to form just one histogram hereafter called “single mode spectrum”.



Institute of Nuclear Research (ATOMIKI), Debrecen, Hungary



Eur. Phys. J. A 44, 513–519 (2010)

Clover Measurement in Hall A

The second part is fed into an analog summing unit implementing the gain-matching and summing of the four signals. The analog sum signal is then passed to a fifth main amplifier and digitized. The signal can then be recorded either in free-running, self-triggered, mode (called hereafter “adddback mode, free-running”) or in anti-coincidence with the signal from the BGO escape suppression shield (called hereafter “adddback mode, escape-suppressed”). The virtual large detector formed by the addback mode has 122% relative efficiency.

Analysis in progress!

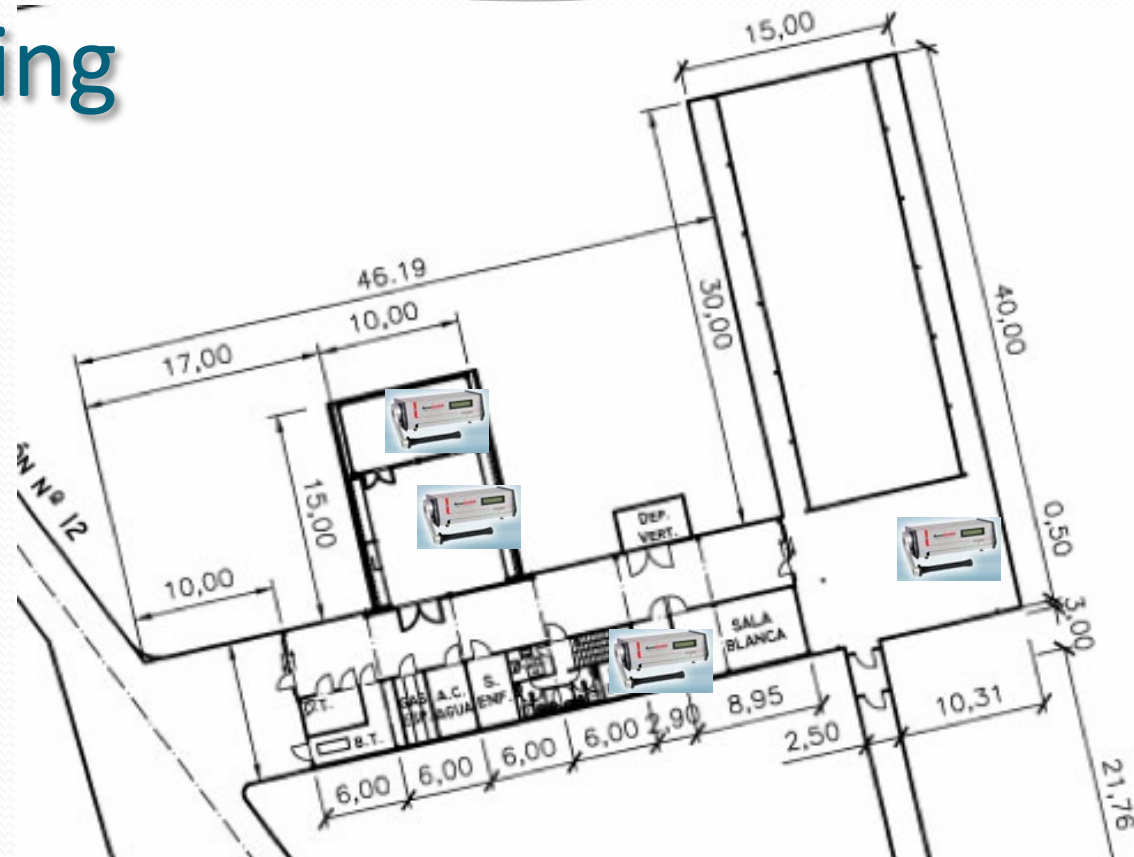
Gamma background in Hall A

$$\gamma \cdot \text{cm}^{-2} \cdot \text{s}^{-1}$$

GeOroel 2010:

40K	0.52 ± 0.23
238U	0.35 ± 0.03
232Th	0.19 ± 0.04
Total	1.06 ± 0.3

Radon Monitoring



4 AlphaGUARD Rn monitors
(pulse-counting ionization chamber
– alpha spectroscopy) situated in:

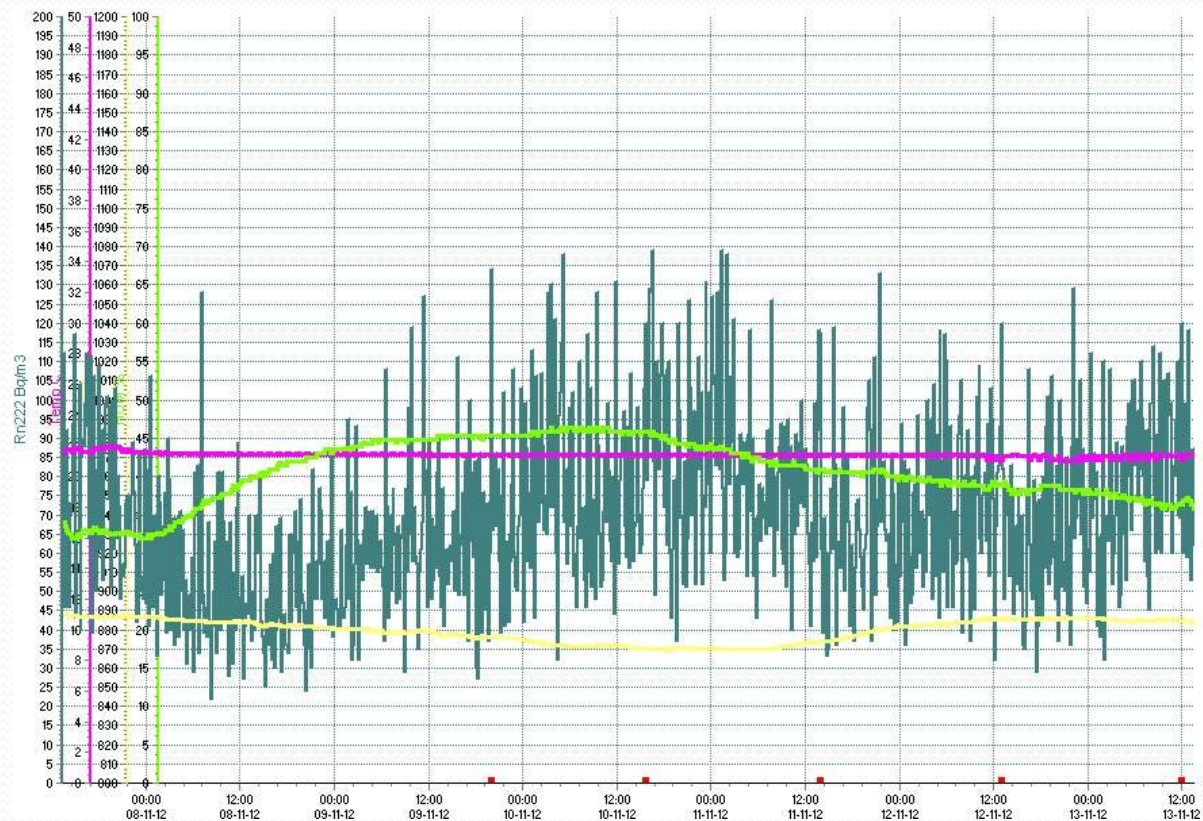
- entrance of air in the lab (LSC),
- Hall A,
- Hall B,
- Hall C.



Data measured and analyzed
in collaboration with LABAC.

Underground Synergies 2012 *Durham, UK*

Radon Monitoring



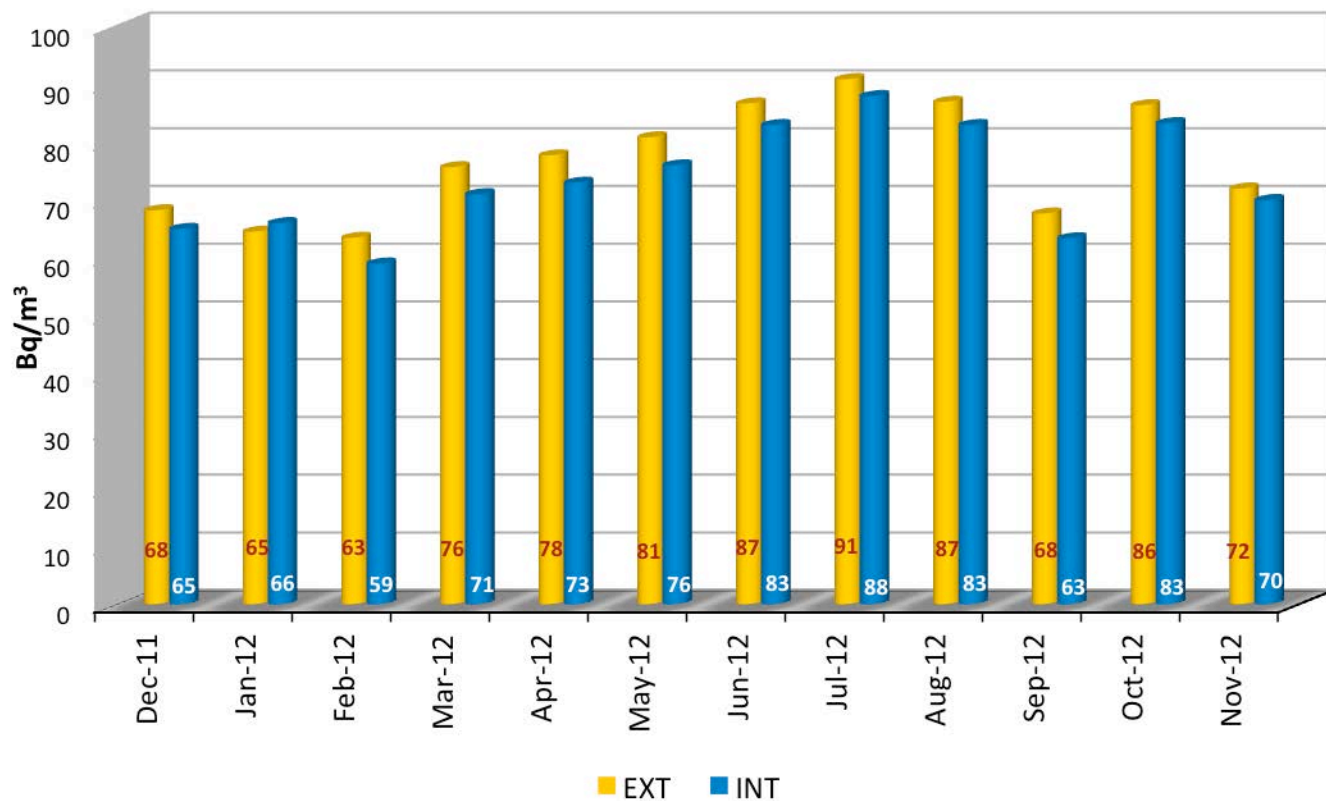
Hall C

Underground Synergies 2012 *Durham, UK*



Data measured and analyzed
in collaboration with LABAC.

Radon Monitoring



Rn222 Monthly Values(Bq/m³)

(December 1st 2011 – November 30th 2012)

Radon Monitoring

Month	EXT			INT		
	Average Value	Max. Value	Min. Value	Average Value	Max. Value	Min. Value
Dec-11	68	107	46	65	105	44
Jan-12	65	94	37	66	94	37
Feb-12	63	79	39	59	76	39
Mar-12	76	90	44	71	85	37
Apr-12	78	101	54	73	94	50
May-12	81	122	54	76	112	49
Jun-12	87	115	69	83	108	70
Jul-12	91	121	66	88	121	63
Aug-12	87	105	72	83	100	65
Sep-12	78	108	53	75	111	50
Oct-12	86	118	45	83	114	46
Nov-12	72	86	54	70	85	51
Year	78	122	44	74	121	37

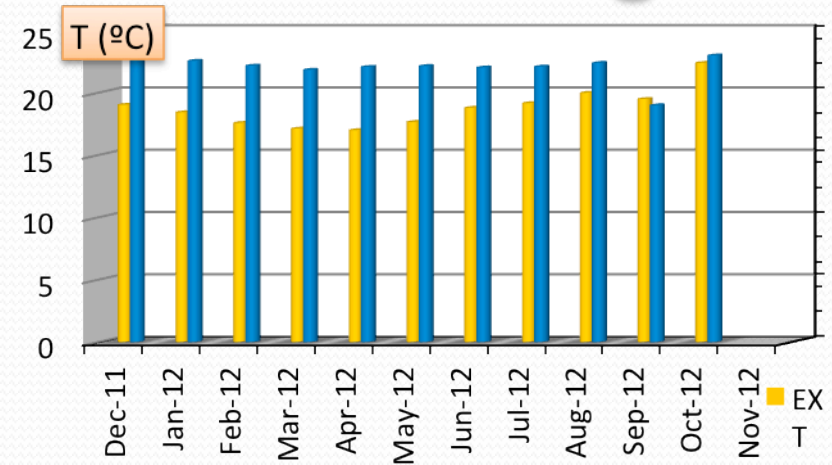


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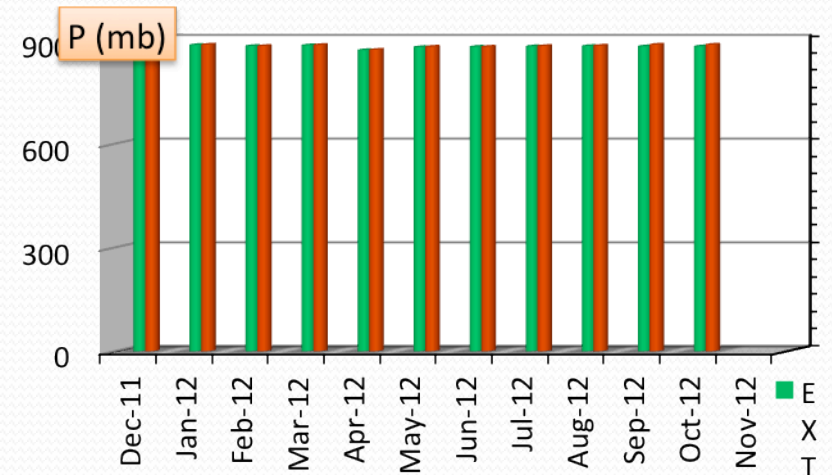
Underground Synergies 2012 *Durham, UK*

Temperature & Pressure Monitoring

Month	T (°C)	
	EXT	INT
Dec-11	19,0	22,6
Jan-12	18,4	22,6
Feb-12	17,6	22,2
Mar-12	17,1	21,8
Apr-12	17,0	22,1
May-12	17,7	22,2
Jun-12	18,8	22,0
Jul-12	19,2	22,1
Aug-12	20,0	22,4
Sep-12	19,5	19,0
Oct-12	22,4	23,0
Nov-12		



Month	P (mb)	
	EXT	INT
Dec-11	886	887
Jan-12	886	887
Feb-12	883	883
Mar-12	885	886
Apr-12	871	872
May-12	880	881
Jun-12	881	881
Jul-12	882	883
Aug-12	883	884
Sep-12	882	887
Oct-12	882	887
Nov-12		



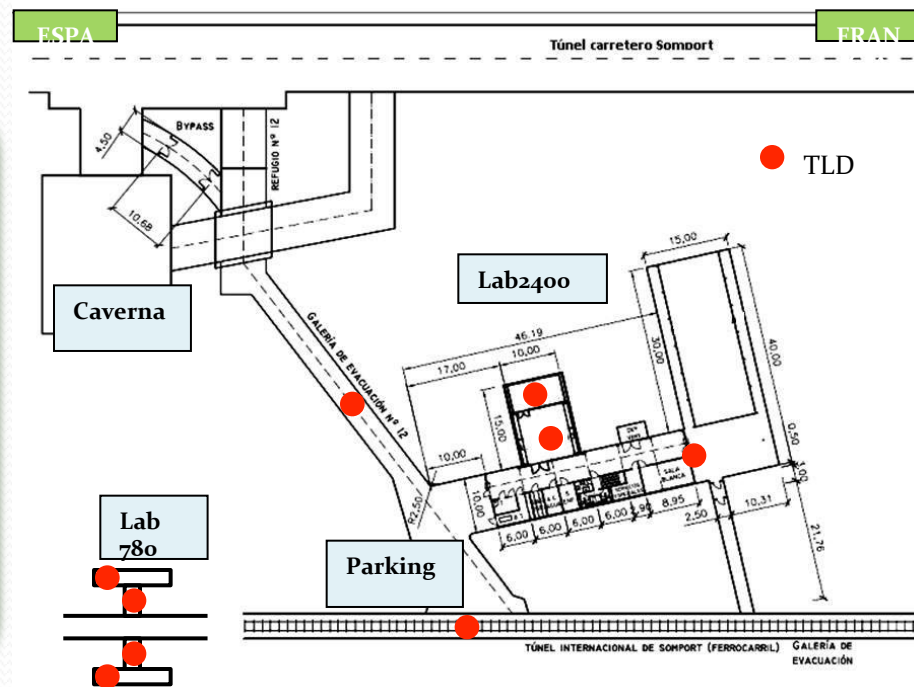
Data measured and analyzed
in collaboration with LABAC.

Underground Synergies 2012 Durham, UK

Radioactivity Measurements with TLD dosimeters

Underground Lab

1. Hall A
2. Hall B
3. Hall C
4. Parking (Tunnel)
5. Lab 2400 offices
6. Gallery 12
7. Lab 780 E Low
8. Lab 780 E High
9. Lab 780 W Low
10. Lab 780 W High



Office Building

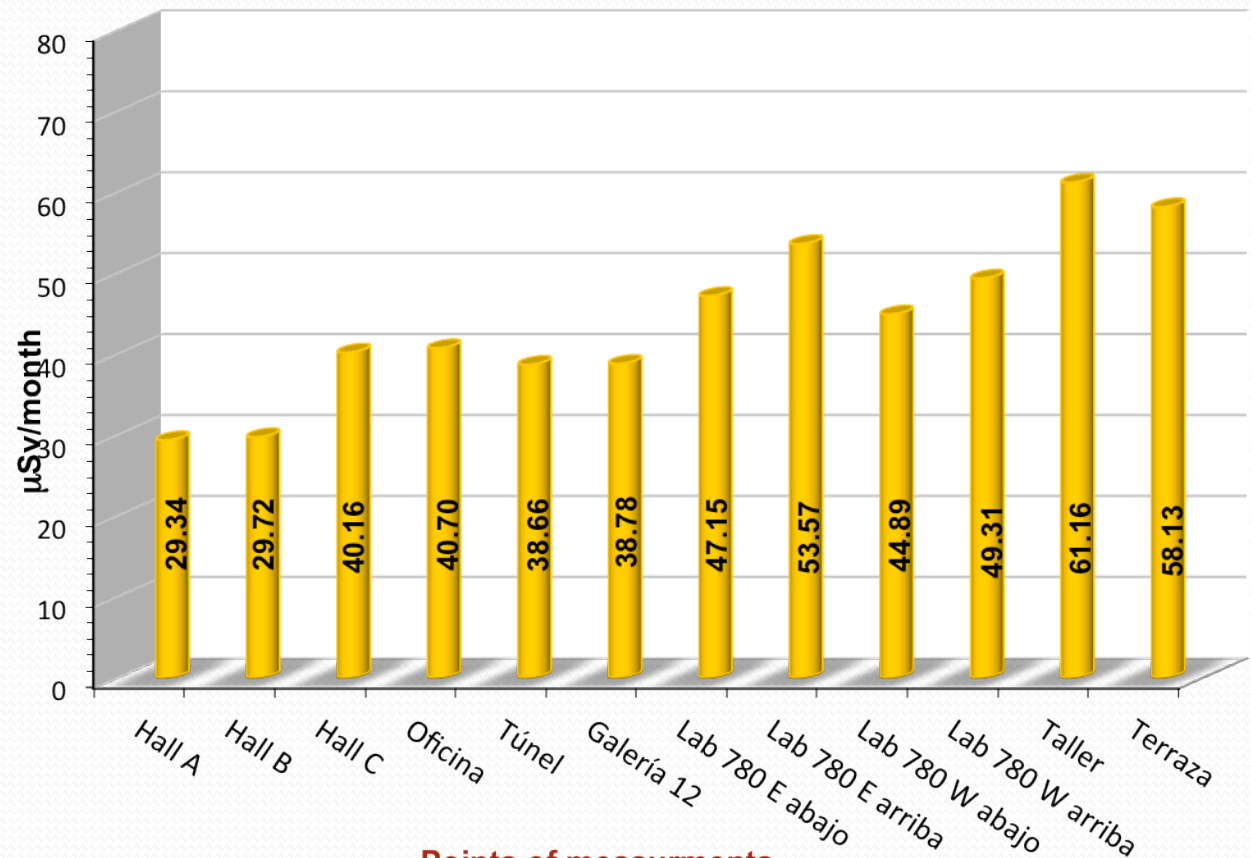
11. Mechanical Workshop
12. Terasa



Data measured and analyzed
in collaboration with LABAC.

Radioactivity Measurements with TLD dosimeters

Environmental Radiactivity in LSC: Dosis in $\mu\text{Sv}/\text{month}$

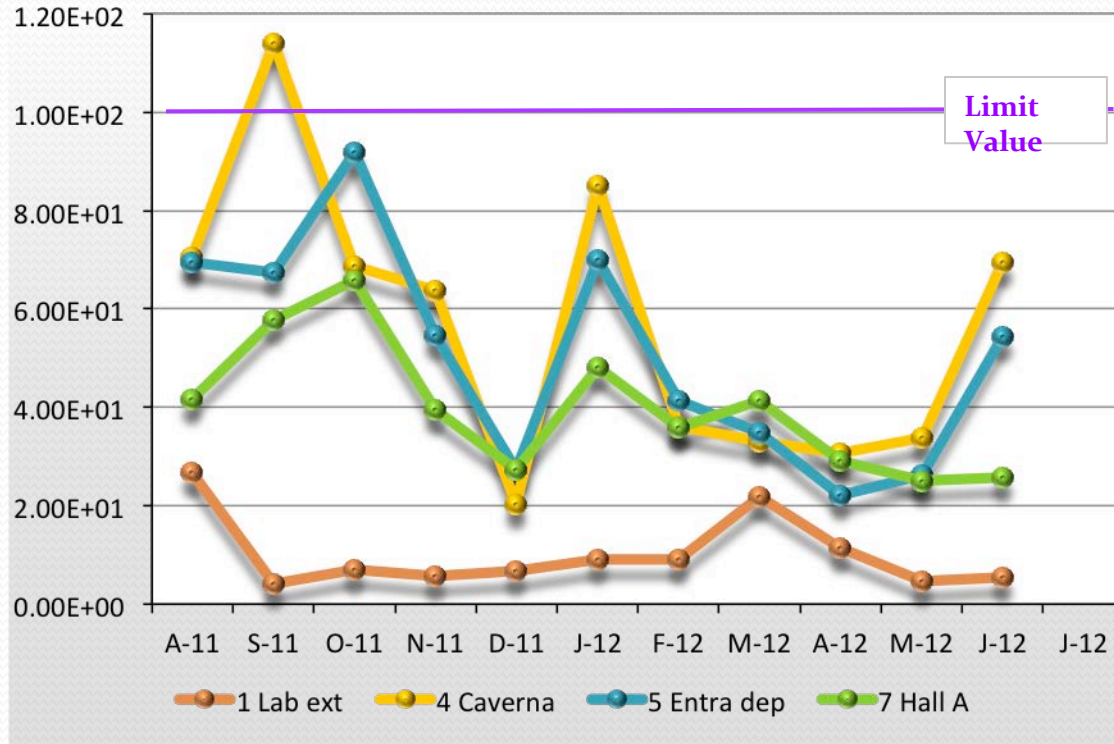


Data measured and analyzed
in collaboration with LABAC.

Points of measurements

Underground Synergies 2012 Durham, UK

Total α Activity Index in Water

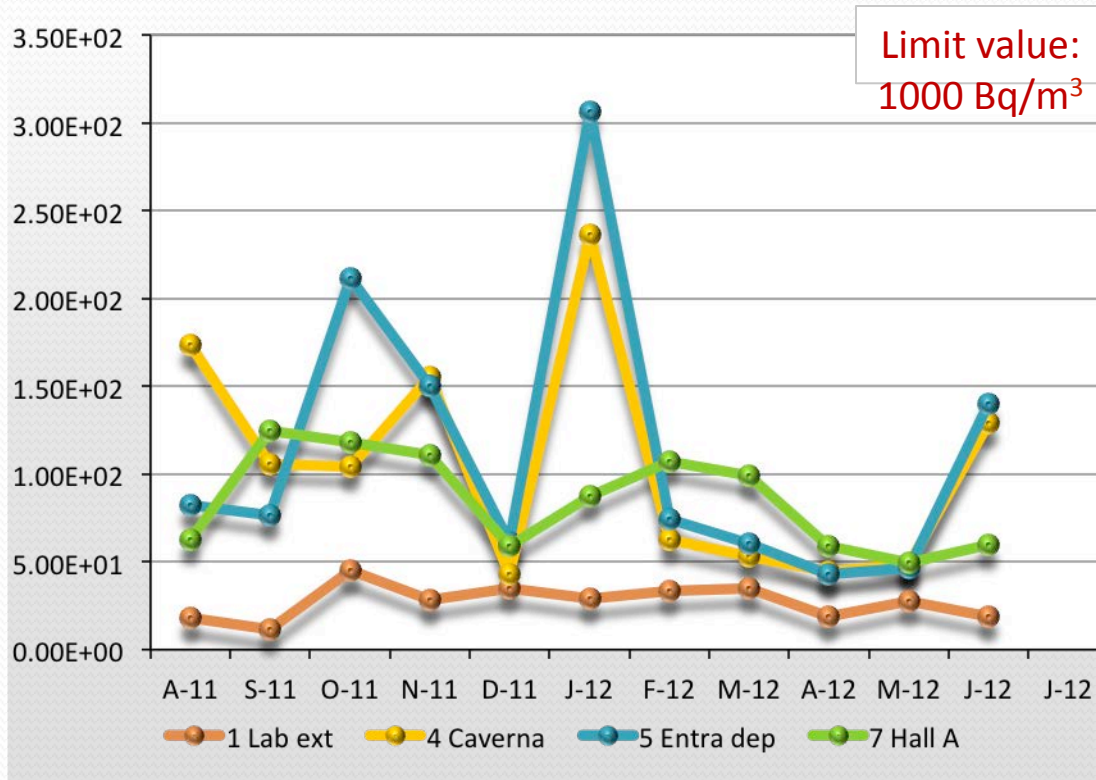


Total α Activity (Bq/m ³) in Water				
Date	1 Lab ext	4 Caverna	5 Entra dep	7 Hall A
Aug-11	2,68E+01	7,06E+01	6,95E+01	4,16E+01
Sep-11	4,13E+00	1,14E+02	6,73E+01	5,77E+01
Oct-11	7,13E+00	6,87E+01	9,18E+01	6,58E+01
Nov-11	5,67E+00	6,37E+01	5,47E+01	3,95E+01
Dec-11	6,63E+00	2,04E+01	2,74E+01	2,74E+01
Jan-12	9,02E+00	8,50E+01	6,99E+01	4,82E+01
Feb-12	8,98E+00	3,61E+01	4,13E+01	3,60E+01
Mar-12	2,19E+01	3,30E+01	3,50E+01	4,14E+01
Apr-12	1,15E+01	3,06E+01	2,21E+01	2,92E+01
May-12	4,65E+00	3,38E+01	2,63E+01	2,51E+01
Jun-12	5,51E+00	6,96E+01	5,45E+01	2,58E+01
Jul-12				
Uncertainty				
Aug-11	1,81E+00	7,22E+00	7,17E+00	5,59E+00
Sep-11	1,57E+00	7,08E+00	5,46E+00	5,07E+00
Oct-11	1,89E+00	5,55E+00	6,18E+00	5,25E+00
Nov-11	1,44E+00	4,46E+00	4,14E+00	3,52E+00
Dec-11	1,59E+00	2,56E+00	3,02E+00	3,02E+00
Jan-12	1,76E+00	5,95E+00	5,41E+00	3,88E+00
Feb-12	2,13E+00	3,91E+00	4,16E+00	3,91E+00
Mar-12	3,09E+00	3,82E+00	3,92E+00	4,17E+00
Apr-12	1,97E+00	3,11E+00	2,66E+00	3,04E+00
May-12	1,42E+00	3,83E+00	3,42E+00	3,34E+00
Jun-12	1,82E+00	5,40E+00	4,80E+00	3,39E+00
Jul-12				



Data measured and analyzed in collaboration with LABAC.

Total β Activity Index in Water



Total β Activity (Bq/m ³) in Water				
Date	1 Lab ext	4 Caverna	5 Entra dep	7 Hall A
Aug-11	1,78E+01	1,74E+02	8,24E+01	6,27E+01
Sep-11	1,12E+01	1,06E+02	7,66E+01	1,25E+02
Oct-11	4,49E+01	1,04E+02	2,12E+02	1,18E+02
Nov-11	2,84E+01	1,55E+02	1,50E+02	1,11E+02
Dec-11	3,47E+01	4,26E+01	6,14E+01	5,89E+01
Jan-12	2,87E+01	2,36E+02	3,06E+02	8,72E+01
Feb-12	3,31E+01	6,27E+01	7,40E+01	1,07E+02
Mar-12	3,52E+01	5,31E+01	6,01E+01	9,94E+01
Apr-12	1,86E+01	4,44E+01	4,27E+01	5,89E+01
May-12	2,79E+01	4,89E+01	4,68E+01	4,94E+01
Jun-12	1,90E+01	1,29E+02	1,40E+02	5,96E+01
Jul-12				

Uncertainty				
Date	1 Lab ext	4 Caverna	5 Entra dep	7 Hall A
Auo-11	1,43E+01	1,92E+01	1,72E+01	1,44E+01
Sep-11	2,17E+01	3,07E+01	2,50E+01	2,75E+01
Oct-11	2,29E+01	2,51E+01	3,10E+01	2,59E+01
Nov-11	1,70E+01	2,53E+01	2,30E+01	2,11E+01
Dec-11	1,77E+01	2,02E+01	2,11E+01	1,83E+01
Jan-12	1,78E+01	3,53E+01	3,52E+01	2,08E+01
Feb-12	2,33E+01	2,47E+01	2,90E+01	2,70E+01
Mar-12	2,34E+01	2,74E+01	2,31E+01	2,66E+01
Apr-12	1,75E+01	1,85E+01	2,21E+01	1,93E+01
May-12	2,08E+01	2,51E+01	2,24E+01	2,56E+01
Jun-12	2,02E+01	2,73E+01	2,69E+01	2,24E+01
Jul-12				



Data measured and analyzed
in collaboration with LABAC.

Water Quality Indicators: Physical, Chemical, Microbiological Parameters

Chemistry Lab			Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12
Parameter	Units	Guiding value												
pH (20°C)	-	6,5-9,5	7,909	8,201	7,816	8,333	8,131	7,143	7,828	8,291	7,904	8,28	7,954	8,185
Conductivity (20°C)	µS/cm	2500	260	224	212	228	125,6	224	231	236	266	192,3	205	218
Oxidizable matter	mg/L	5	8,27	8,25	7,8	8,89	8,9	8,77	8,46	9,74	8,8	9,27	8,86	8,73
Nitrats	mg/L NO3-	50	< 1,0	< 1,0	< 1,0	< 1,0	1	< 1	1	1,1	< 1	< 1,0	< 1	< 1
Nitrits	mg/L NO2-	0,5	< 0,01	< 0,01	< 0,01	0,01	0,01	0,01	0,02	0,01	< 0,01	< 0,01	< 0,01	< 0,01
Iron	mg/L	0,2	< 0,10	< 0,10	< 0,10	< 0,10	< 0,10	< 0,1	< 0,1	< 0,1	< 0,1	< 0,1	< 0,1	< 0,1
Turbidity	FAU	1-5 UNF	-	6	< 4	7	6	< 4	< 4	< 4	< 4	< 4	< 4	< 4
Amonium	mg/L NH4-	0,5	< 0,1	< 0,1	< 0,1	< 0,1	< 0,1	< 0,1	< 0,1	< 0,1	< 0,1	< 0,1	< 0,1	< 0,1
Sulphats	mg/L SO42-										< 20	< 20	< 20	< 20
Phosphats	mg/L PO43-	10	< 0,2	< 0,2	< 0,2	< 0,2	0,2							
Total hardness	mg/L CaCO3	300	-	160,2	115,7	172,66	142,4	131,72	142,4	178	147,74	133,5	115,7	80,1
Alcalinity	mg/L CaCO3		-	124,6	106,8	124,6	128,16	124,6	124,6	115,7	151,3	133,5	133,5	121,04
Total count	UFC/100 mL	100 UFC/ mL	2	1	7		> 300	66	54	1	2	0	0	> 200
Coliforms	UFC/100 mL	0	1	1	0		1	1	1	0	1	0	0	0
E. coli	UFC/100 mL	0	1	1	0		1	1	1	0	1	0	0	0



Data measured and analyzed in collaboration with LABAC.

Water Quality Indicators: Physical, Chemical, Microbiological Parameters



Data measured and analyzed
in collaboration with LABAC.

Underground Synergies 2012 *Durham, UK*

To do

- Continue material screening for experiments.
- Clean shields and mount the 2 HpGe in Hall C.
- Buy materials and modify all mounted detectors shields so that to include 10 cm of Cu and a door.
- MC studies of the detectors backgrounds.
- Design, mount, and test a better Rn shield made of stainless steel.
- Continue monitoring Rn and environmental parameters inside LSC and office building.

Thank you!