



Berkeley Low Background Facility: Services and Updates

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SURF Users Association
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Al Smith

The father of low background counting

June 2nd, 1926 to May 8, 2019

For over 65 years, Al Smith developed and enhanced low background assay techniques. He performed assays for many of the most significant physics experiments of our time, including UCSB-LBL Ge Experiment, CDMS, SNO, SNO+, KamLAND, CUORE, LUX, LZ, KATRIN, Daya Bay, Majorana Demonstrator, and LEGEND.

Al worked at Lawrence Berkeley National Laboratory from 1953 until his passing in 2019. He was instrumental in creating the Black Hills Underground Campus assay capabilities, and trained generations of physicists in the art of low background counting.

Berkeley Low Background Facility



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Provides low background, gamma spectroscopy services to a wide variety of projects/experiments

- passive counting for U, Th, K, Co ...
(and common man-made/cosmogenics)
- *neutron activation analysis of U, Th, K or other trace elements*
- *neutron flux measurements (beam characterization, etc.)*
- *environmental measurements, waste assay, etc.*

Long History of Low Background Counting

- > 60 years experience
- SNO, KamLAND, CUORE, DoubleCHOOZ, Daya Bay, Majorana, KATRIN, Sanford Lab, LUX/LZ, + more.

**** BLBF Open to any project/experiment ****

Requests for service can be made at website.

<http://lbf.lbl.gov>

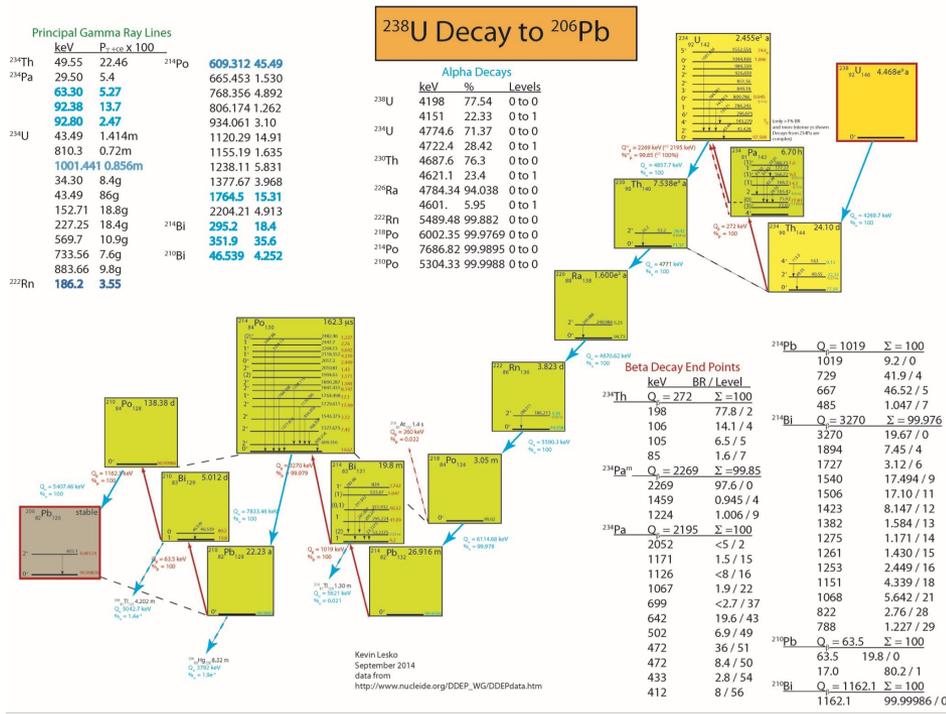


Why HPGe Assays?



Pros

- Integral measurement of full sample activities
- Non-destructively assays activities from the full chain
- Enables assays of components and final assemblies
- Less susceptibility to measurement-systematics & assay-contamination
- Significantly lower costs to assay
- Sensitive to surprises
- Impressive advances in sensitivity
- Coincident γ -ray measurements possible with multi-crystal arrays
- Spectra interpretable by anyone



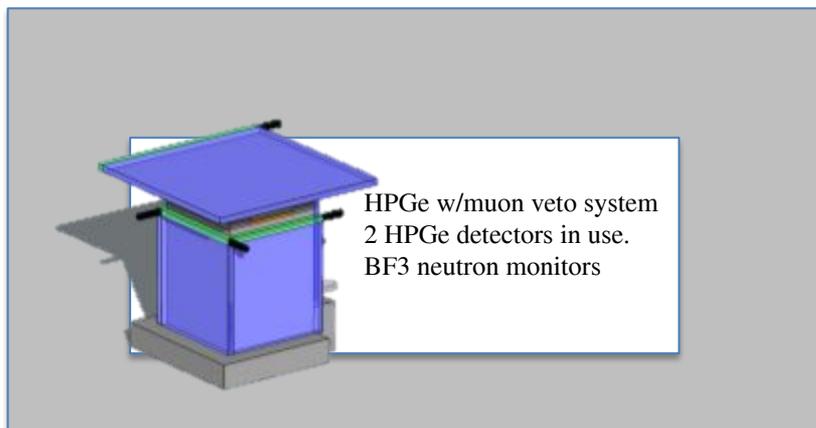
Cons

- Larger samples
- Lower sensitivities to some species
- Longer assay times
- Won't have to listen to some lab's sales pitch and deal with your SPO to fund expensive sub-contracts
- Won't get to play with HF or Aqua Regia

Facilities and Equipment

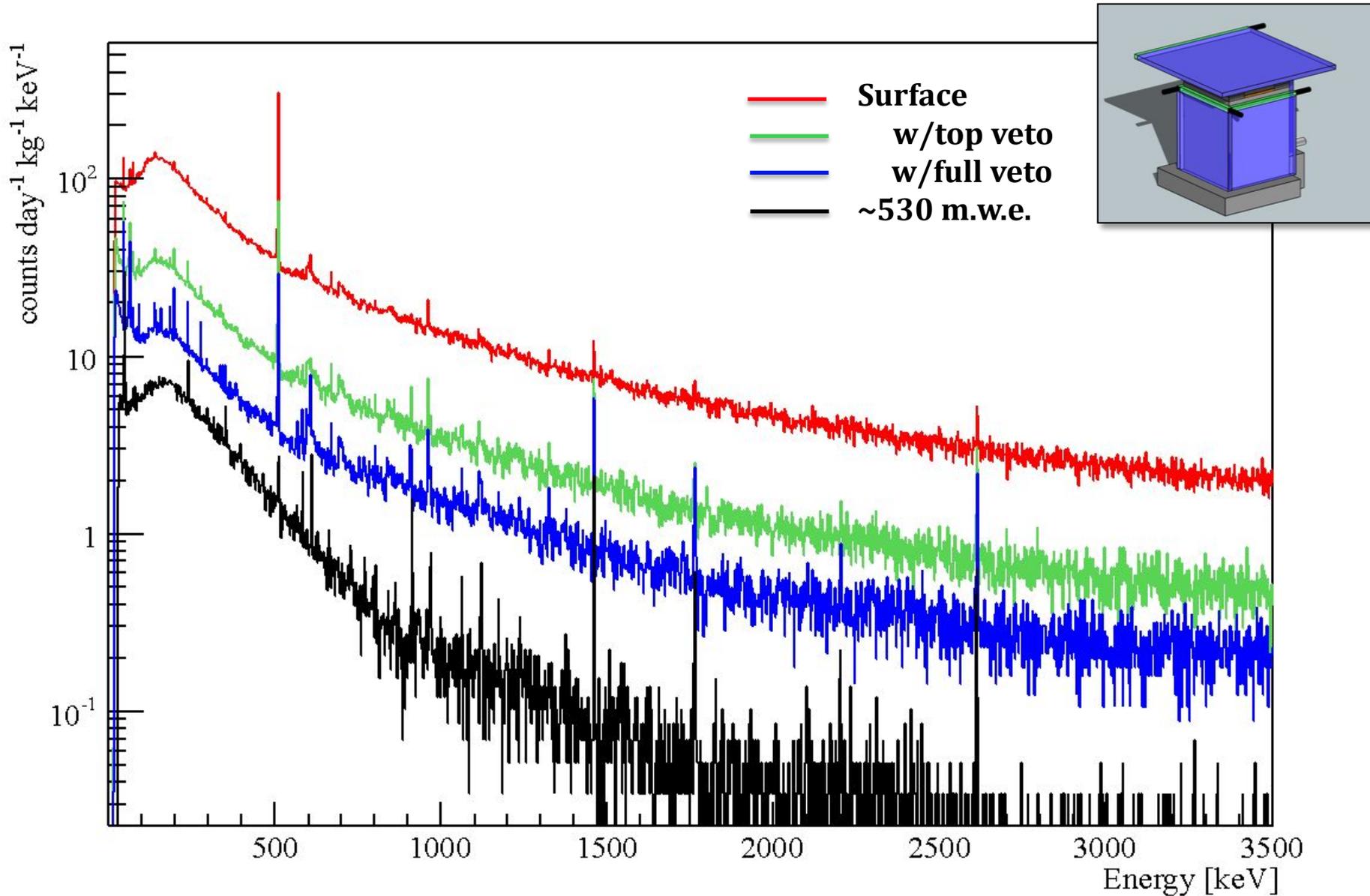
Local Site LBNL	
backgrounds dominated by cosmic ray muons, Muon Veto in use	
1 x 115% n-type ORTEC GMX LLB-HJ; Plastic Veto [4" Pb, 0.5" OFHC Cu] N2 radon purge	1 x 85% p-type GEM XLB-SL NaI Veto [4" Pb, 0.5" OFHC Cu] N2 radon purge

Counting Sensitivities [for ~1kg samples]	Berkeley Site [~1 day]
U series	0.5 ppb (6 mBq/kg)
Th series	2.0 ppb (8 mBq/kg)
K	1.0 ppm (30 mBq/kg)



Low Background Counting: Samples are typically counted first at the surface LBNL site, where pending the results (limit or measured value; and requestor's interests) they are then sent to SURF for a more sensitive count. (prioritizes underground spectrometer for samples that actually require the sensitivity.)

Muon Veto System



International Consortium for Low Background Counting

Building on the successful collaboration for LZ and expanding the scope for G3 dark matter and tonne-scale neutrinoless double-beta decay, several groups have established a consortium: **Berkeley, Black Hills, Boulby, Baudis, & Mark Schuman** have begun by cross calibrating detectors and exchanging samples of interest. Stay tuned.

Neutron Activation Analysis

Perform irradiation of samples at either MNRC, MIT, others.

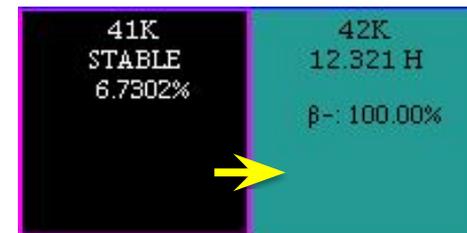
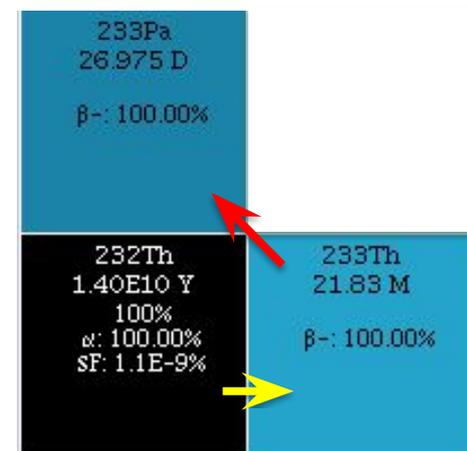
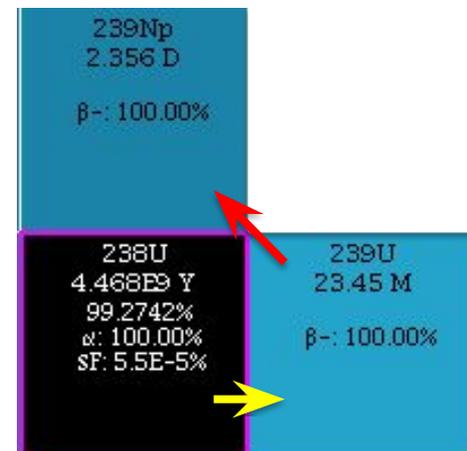
- Ship back to LBNL for counting and analysis.
- Performed several irradiations in 2014
 - Established timely procedures for samples

Use of standard monitors to either directly monitor the activation of an isotope of interest, or measure flux.

- Use of ratio method for measuring concentrations
--cancels out systematic uncertainties (flux, efficiencies, etc.)

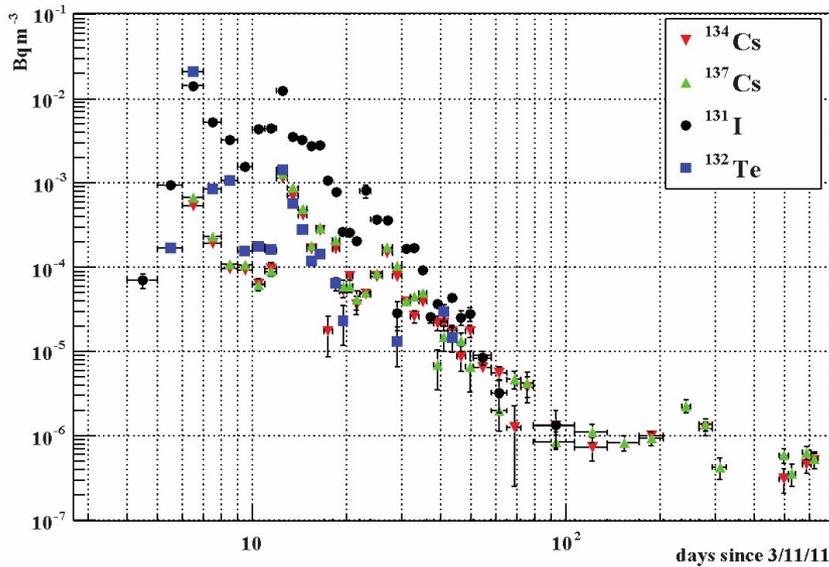
Sensitivity- Your mileage may vary...

- typically limited by either bulk material composition or contaminants
- Common competing isotopes in samples lately have been ^{82}Br , ^{24}Na , ^{198}Au , ^{187}W , etc.

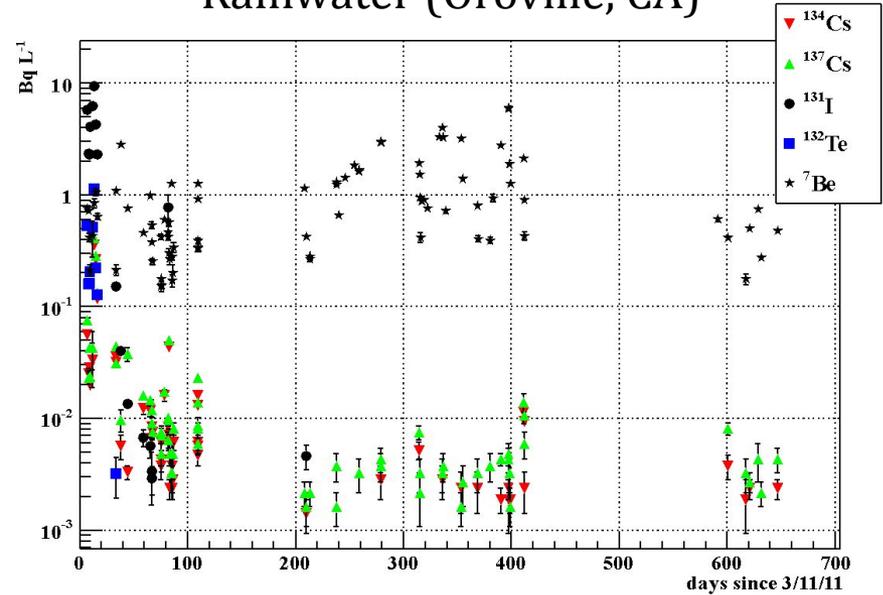


Environmental Monitoring

Air Sampler HEPA Filters (LBNL)



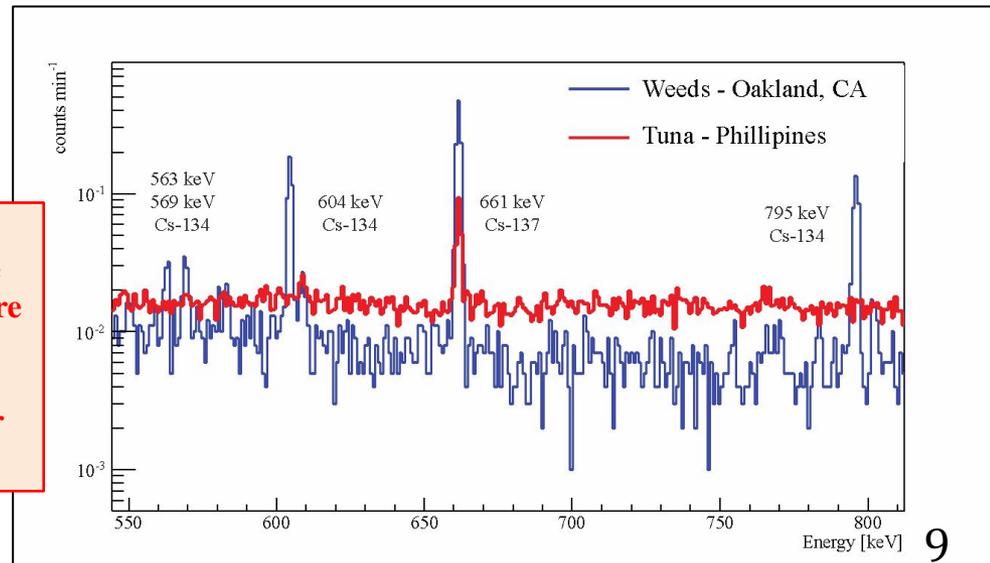
Rainwater (Oroville, CA)



Summary of Fukushima related measurements through the end of 2012 posted. Including air filters, automobile filters, soil, rainwater, and a set of 2013 samples of seafood. (open access journal)



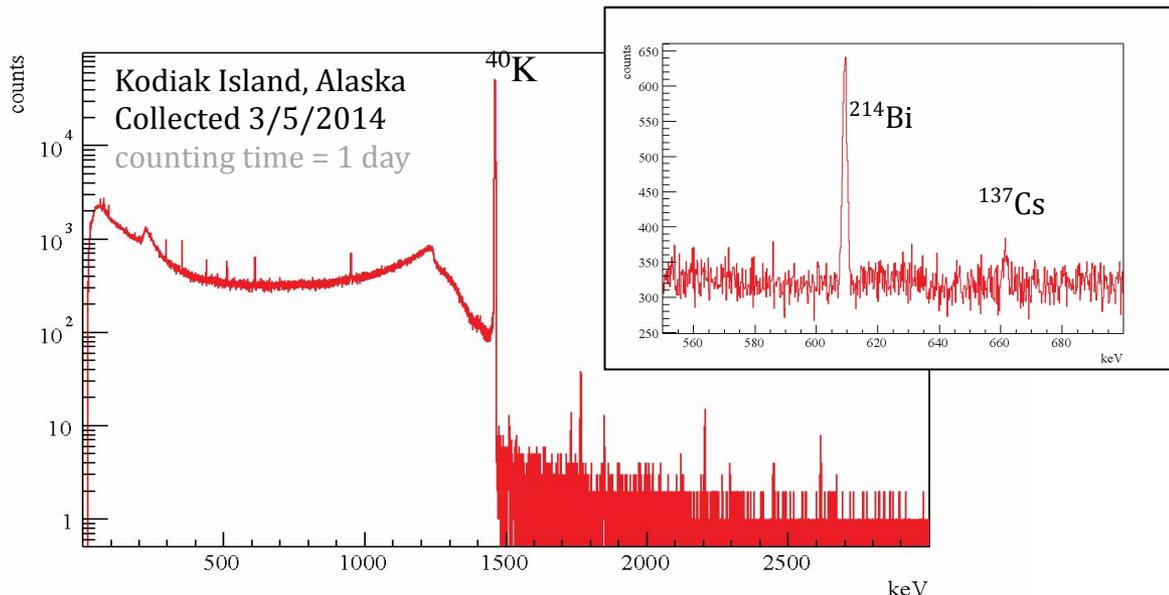
Over 1200 automobile filters counted since 2002 with no trace of man-made radioactivity before Fukushima. The Fukushima Incident provided a proof-of-principle for monitoring method.



KelpWatch 2014

<http://kelpwatch.berkeley.edu>

Project PI:
 Steven Manley, CSULB
Analysis and Reporting:
 Kai Vetter, UCB/LBNL
 Mark Bandstra, LBNL
 Al Smith, LBNL
 Keenan Thomas, UCB/LBNL



- Quell rumors and reports of Fukushima radiation being a significant problem for Pacific Coast of North America.
- Educate public on natural radiation
- Always report ^{40}K , ^7Be , U and Th series, etc. for context.
- No definitive evidence of Fukushima related isotopes yet over BKG.

isotope	Bq/kg (dry)	
^{40}K	1900 - 4600	3370
U early	16 - 760	135
U late	0.3 - 4.0	1.8
Th early	0.1 - 5.0	1.0
Th late	0.05 - 1.2	0.3
^7Be	0.75 - 45	4.0

isotope	Bq/kg (dry)
^{137}Cs (legacy)	0.10 - 0.50
^{134}Cs	< 0.04
^{131}I (medical)	1 - 250

Summary

The Berkeley Low Background Facility is an active screening facility specializing in low background gamma spectroscopy.

Provides measurements of:

- Passive, non-destructive, low background counting of U, Th, K or other radioisotopes for physics projects. Mostly as a pre-screener, but also to boost assay capacity.
- *Neutron activation analysis for U, Th, K or other trace elements of interest.*
- *Neutron beam, foil activation measurements.*
- *Environmental Monitoring, Waste Assay, etc.*

Open to any project/experiment.

Recent Publications

[The LUX-ZEPLIN \(LZ\) radioactivity and cleanliness control programs](#)

- *Eur.Phys.J.C* 80 (2020) 11, 1044
- [2006.02506](#) [physics.ins-det]

[Measurement of the gamma ray background in the Davis cavern at the Sanford Underground Research Facility](#)

- *Astropart.Phys.* 116 (2020) 102391
- [1904.02112](#) [physics.ins-det]

[Identification of Radiopure Titanium for the LZ Dark Matter Experiment and Future Rare Event Searches](#)

- *Astropart.Phys.* 96 (2017) 1-10
- [1702.02646](#) [physics.ins-det]

Thank You



Visit us at
<http://lbf.lbl.gov>

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Lawrence Berkeley
National Laboratory



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Backup slides