University of Utrecht

Labcourse: Radioactive Backgrounds

December 19, 2014

A.P. Colijn, C.D. Tunnell, M.K.M. Bader, B. Pelssers

contact: [colijn@nikhef.nl](mailto:colijn@nikhef.nl)

Table of Contents

1 Radioactive Backgrounds 2

2 The Experiment 2

3 Lab report 2

# Radioactive Backgrounds

There are numerous sources of natural radioactive backgrounds constantly ‘providing’ us with a small dose of ionizing radiation. Although normally the dose incurred by these natural backgrounds is low, for dark matter detection experiments the natural dose is prohibitive. All dark matter experiments take precautionary measures to eliminate radioactive backgrounds. During this lab course we will investigate what kind of backgrounds dark matter experiments have to deal with. The ultimate goal of the experiment is to estimate the 238U and 232Th contaminations inside the lecture room where we do the experiments

# The Experiment

We have two scintillation detectors available for this lab course: one NaI and one BGO crystal with a photo-multiplier tube (PMT) connected to it. These detectors are well suited to detect gamma rays. The detectors come together with a custom-made readout system, which measures the energy and also supplies a high-voltage to the PMT.

Below is a short recipe for the lab course

1. quickly familiarize yourself with the detectors: a scintillator + PMT is one of the most widely used detection systems in physics (not just particle physics), so this will benefit your general education.
2. understand how your radioactive source provides you with gamma rays.
3. calibrate the energy scale of your detector using one or more of the radioactive sources
4. measure the background rate in the lab
5. work on an estimate of the 238U and 232Th contamination. To get to an answer will require probably a lot of wild guesses, next to the solid physics assumptions.

# Lab report

I expect a max 10 page lab report on this experiment. In the report the following topics should be addressed:

* What are the sources of natural backgrounds?
* How does a NaI / BGO scintillation detector work?
* By what mechanism do you stop gamma rays inside a NaI/BGO detector?
* How did you calibrate the energy scale of your detector.
* How do you get gamma rays from a beta source?
* What is your estimate of the activity in the lecture room?

# Useful links

* X-ray attenuation: <http://www.nist.gov/pml/data/xcom/>. You can calculate attenuation of your crystal materials NaI and BGO.
* Scintillators: <http://scintillator.lbl.gov>