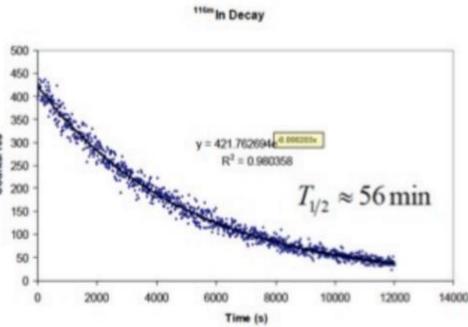


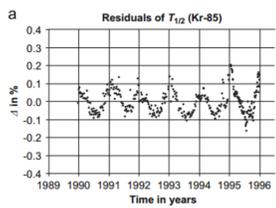
Experiment

The Modulation experiment has the goal to determine whether nuclear decay rates can be influenced by external perturbations, adding time-dependent parameters to the process. Decay processes are considered stochastic phenomena, in contrast to the belief of a few physicists[1] who claim that this process is in fact not completely random.



$$N(t) = N_0 e^{-\lambda t}$$

Unexplained periodic variations have been reported recently by a number of groups in experiments with a variety of isotopes[2]. These fluctuations have been observed from various sites, using different detector technologies (Brookhaven National Laboratory (BNL), Physikalisch Technische Bundesanstalt[3] (PTB), Gran Sasso National Laboratory (DAMA/LIBRA Experiment)[4], etc). Fischbach[1] suggests the possibility of a direct solar influence on nuclear decay rates, while DAMA/LIBRA[4] investigates the relationship between the presence of Dark Matter particles in the galactic halo and the observed variation.



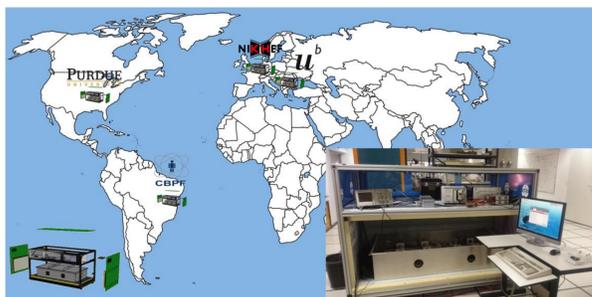
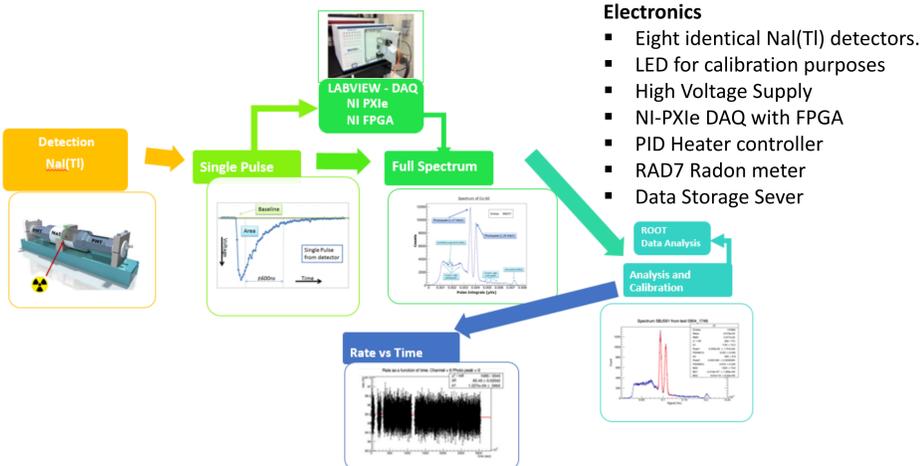
Measurements made by PTB and BNL [1]

- Periodicity of 1 year
- Amplitude of 0.1%
- Phase max occurs in February and min in August.

$$\lambda(t) = ??$$

Systematic
Or
Dynamics

Data acquisition and Signal Processing



The Modulation Experiment

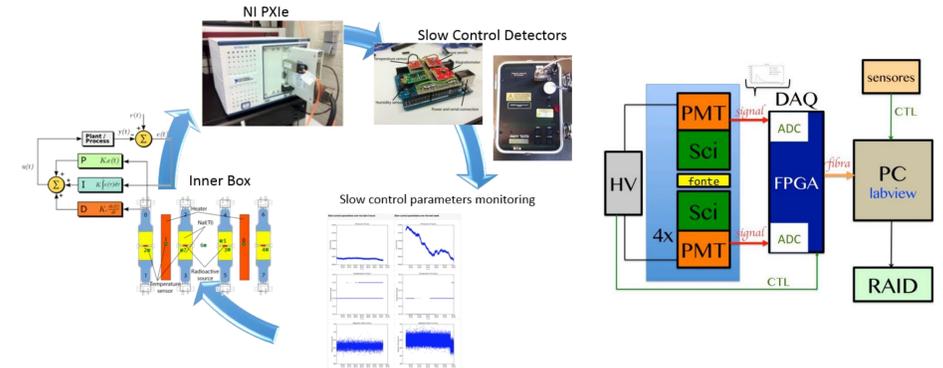
- Amsterdam (Netherlands)
- Bern (Switzerland)
- Indiana (United States)
- Rio de Janeiro (Brasil) – The only setup placed in South America.

Requirements

- Collect data over a period of 1 year from 4 different sources.
- Control of systematic effects and external parameters, such as temperature, radon concentration, Magnetic field, humidity, etc, and compare the results, excluding local influences.
- Minimal activity of the sources ^{40}K , ^{54}Mn , ^{60}Co , ^{133}Ba and ^{137}Cs need to be in the order of 10^1Bq , 10^4Bq , 10^1Bq , 10^1Bq , 10^7Bq respectively.
- Recording not merely spectra but every individual pulse.

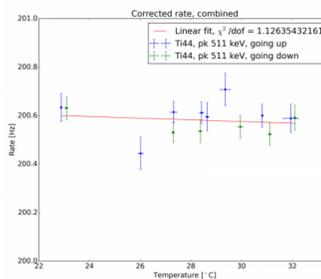
Slow Control

The slow control system is placed inside the inner box of the experiment and is outfitted with several sensors that have the objective to account even the smallest contributions to background and monitoring of seasonal influences in the decay rate of radioactive sources (temperature, radon concentration, Magnetic field, humidity, etc), as well as systematic effects that might appear during the experiment.



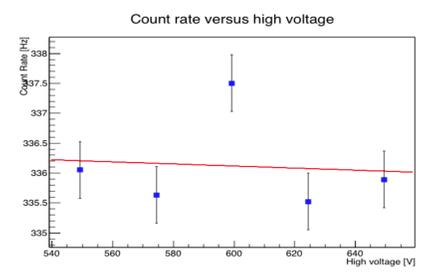
Slow Control Measurements

Counting Rate Vs Temperature



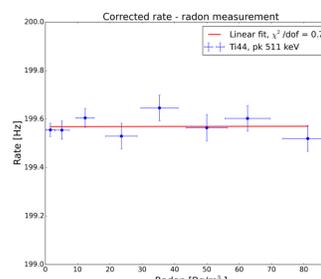
Temperature vs Corrected Rate.

Counting Rate Vs High Voltage



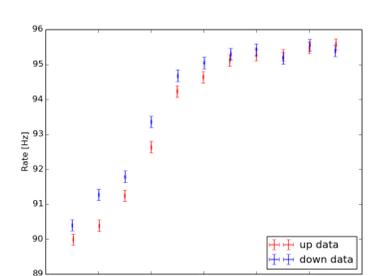
Decay rate as a function of HV setting.

Counting Rate Vs Radon Levels



Decay rate as a function of Radon.

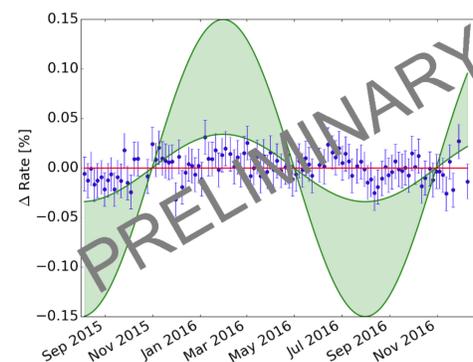
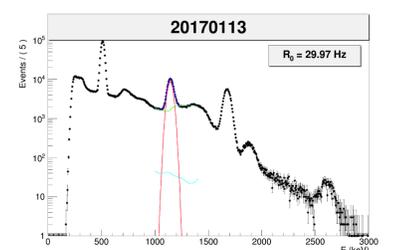
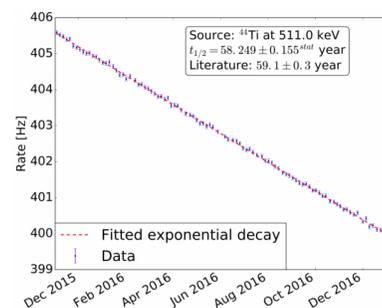
Counting Rate Vs Pressure



Measured rate vs pressure.

Analysis

The analysis is done for the whole spectrum and for the photopeak region individually. The fast control accounts to signal processing (hardware) and data treatment (software), including calibration and data analysis. The modulation is extracted from the residual pattern exhibited from the activity of the sources.



- O'Keefe et al. 2012, amplitude 0.034 – 0.15% max. at 29 jan
- No modulation
- + Data - exponential decay

PRELIMINARY RESULT :
No Modulation has been measured until now.

Next Steps

The Modulation experiment has the objective to obtain measurements that show if there exist modulation in the activity of radioactive nucleus or not and also to understand the source of possible modulations. Past experiments had disadvantages in identifying the source of the observed modulation. The Modulation is being designed to overcome these disadvantages and achieve more sensible and deeper results. In the upcoming months a paper about the experiment will be published and we will start taking data effectively in the 4 setups.