Eventual influence of local environmental variations

The eventual influence of local conditions – instrumental effects and atmospheric - on the radon signal in EXP #1 was extensively elaborated and discussed by Steinitz et al. (2011), in the framework of an environmentally oriented publication platform. Due its importance an excerpt and summary is given below.

Radon alpha and gamma measurement techniques applied are described in detail by Zafrir et al (2011). Further specific details are given by Steinitz and Piatibratova (2008). The specifications of the instruments indicate linearity in the span of ambient temperature. The detector systems (and data logger) are industrial products and frequently utilized, since the 1990"s, in geological and environmental radon surveys. Investigations performed since 1995 by the GSI at diverse field locations and in the laboratory utilize the same industrial systems types (models), while demonstrating their robustness.

The setup of EXP #1 is enclosed within a tight 640 liter tank. It is located above ground under an open shack. The source of radon is a ground phosphorite rock originating from an open pit mine in southern Israel, containing around 120 ppm of Uranium. The ground material is emanating radon into its pores, from where it is supplied by diffusion to the overlying air volume, in which the gamma and alpha sensors are immersed. Primary situational and environmental factors are [Steinitz et al., 2011]:

- The tank wall, made of iron plates, is in thermal equilibrium with the surrounding ambient temperature.
- Internal pressure is in equilibrium with the atmospheric pressure.
- Local conditions led to large temperature variations, from daily to annual scale, spanning some 40°C.
- Slow mixing in the upper volume of air is assumed due to convection inside the tank.
- The tank is in part of the day under direct influence of sunlight.
- The internal radon sensors are in complete darkness.

Investigations of variation patterns of ^{222}Rn in the geological environment applied the common practice of comparison with atmospheric parameters in the time domain or in frequency domain. Such analysis leads to ambiguities and inconclusiveness in terms of interpretation. For a review see Barbosa et al. (2015). Applying advanced analysis of the phenomena in the combined frequency-time domain (MTWF, Steinitz et al, 2007) demonstrated for the first time systematics of radon characteristics that differ extensively from those in temperature and pressure. This formed the basis for claiming that apparent similarity (in the time domain) of signal patterns of radon versus temperature and/or pressure does not substantiate causality. Applying such analysis to several radon time series originating from very different geological situations confirmed the same situation [Steinitz and Piatibratova 2010a,b; Steinitz et al. 2013a; Steinitz et al. 2015]. In a further step, the specific systematics of the periodic signals in the daily and annual frequency bands, combined with the lack of tidal gravity periodicity, led to the suggestion that a component in solar radiation is driving these signals directly.

A similar analysis approach in the frequency-time domain was applied to evaluate the time series of EXP #1 (Steinitz et al., 2011). Due to its above surface location it is influenced by large environmental variation, and therefore considered as under very unfavorable conditions. The Moving-Time-Window Fourier spectral analysis [Steinitz and Piatibratova 2007; Steinitz et al. 2011]. was applied to examine the characteristics of variation in the combined frequency-time domain. The amplitudes of the daily periodic components of the atmospheric pressure, ambient temperature and measured radon signal were derived from FFT spectra calculated per consecutive time intervals. In the case of radon (gamma,. alpha) ratios of the normalized diurnal (24-hour) versus sub-diurnal (12-hour) amplitudes align along a linear pattern, while dispersed patterns are derived for the atmospheric parameters (Figure 21 in Steinitz et al. 2011). It was argued that the dispersed patterns of the atmospheric parameters cannot generate the regular linear pattern observed for the alpha and gamma radiation signal from ^{222}Rn and its progeny. This test was performed on the measured data using a simple statistical analysis, and its outcome is independent of other considerations and modes of analysis. As such the test is robust, and the outcome is therefore considered as an indicative criterion. The results from such examinations of data from EXP #1 do not support the notion of a direct connection between the temporal variation of the ^{222}Rn signal and atmospheric influences, and probably negate it.

Further considerations as to an eventual influence of temperature and/or pressure are arrived at from the analysis presented in the previous sections, and are discussed below.