A new experimental setup for the on-line measurement of radionuclides at the Jungfraujoch high altitude research station

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The Swiss Federal Office of Public Health's environmental radioactivity monitoring network aims at measuring the trends in environmental radioactivity in the region and warns the public of any abnormal occurrence such as an influx in artificial radioactivity.

As part of a recent modernization of this monitoring network a new measurement device was installed at the Jungfraujoch high altitude research station at 3'450 meters asl. This largely self-developed prototype samples about 80'000 cubic meters of ambient air per week through a chlorinated polyvinylchloride filter paper that retains the aerosol particles. An integrated high-purity germanium detector (HPGe) mounted just below the filter paper continuously acquires high-resolution gamma-ray spectra during the sampling period. The spectra are automatically stored and analyzed every 5 minutes which provides (a) an on-line measurement with high temporal resolution and (b) a means to measure any short-lived particle-bound radionuclides such as the Radon daughters Lead-214 or Bismuth-214. Activity concentrations of the detected radionuclides are derived from the peaks in the spectra corresponding to the gamma ray emissions of the radionuclides. The detection of an artificial radionuclide triggers an alarm that requires verification by qualified staff before being transmitted to the civil protection authorities.

After the sampling period of one week, the filter paper is sent to the laboratory. The large volume of sampled air allows for the identification and quantification of tiny amounts of radionuclides in the ambient air. The detection limit of the weekly mean value of Cesium-137 is as low as 1 micro-Bq per cubic meter of air or less and can be compared with the results from the on-line measurement with the integrated HPGe detector.

This poster describes the experimental setup and provides an overview of the instrumental challenges involving the sampling of ambient air under challenging meteorological conditions with a cloud frequency of almost 40 percent, mainly formed by lifting of air masses. The difficulties associated with the sampling of aerosol particles are outlined as well as the influence of cosmic radiation on the gamma ray spectra, primarily via secondary reactions with the material of the HPGe detector itself or its housing.

The instrument is the first of its kind at this altitude and gives insight into the influence of the frequent stratospheric intrusions and the background variations in the free troposphere. Future work will focus on improving the temporal resolution and analyzing the trends in the cosmogenic Beryllium-7 activity concentration.