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CZT detector based spectrometer for drone and balloon borne measurements

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We built a lightweight gamma-ray measurement setup that can be placed in standard weather balloons and can be retrieved after the flight. This allows multiple flights with a relatively small cost. The aim is to get spectral information on radiation at high altitudes. To obtain good spectral resolution with relatively small weight we use a cadmium zinc telluride (CZT) detector which has crystal dimension of 1 cm cubed.

Standard weather balloons can reach altitudes of 40 km depending on the size and material of the balloon and the weight of the payload. Since a fully depleted CZT detector requires fields of the order of 4 kV/cm, the critical limitation at these altitudes arises from the Paschen limit. Thus, we have developed a container which can hold the detector at normal pressure at high altitudes. With commercial components we were able to keep the total weight of the system under 700 grams, way below the 2 kg limit set by aviation safety regulations. The setup consists of a power supply, a single board computer with integrated microcontroller, and the CZT detector. Based on our tests at the laboratory, the system is able to operate at temperatures down to -40 ℃ and at pressures of few hundreds of Pascals for few hours.

In this contribution we present the design of our setup and show some measurement results. The CZT detector is irradiated with laboratory sources in a temperature climate chamber that was cycled down to -40 degrees Celsius. Based on the results, we will discuss the effects of the temperature changes to the radiation measurements and spectral resolution. In addition, we will show the effects of low pressure to the electronics and the power supply. The expected response of the detector at various altitudes based on a Geant4 simulation model is also presented with the planned balloon campaigns.

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