Present status and modernisation of the Dourbes Cosmic Ray Observatory for improved space weather research and forecasting

European Space Weather Week 13, Oostende, 14 – 18 November 2016

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Introduction

A second neutron monitor(DRBS2) for the monitoring of the galactic cosmic rays intensity at ground level is under construction in Dourbes, Belgium. DRBS2 has the main objective to maintain cosmic rays monitoring in Belgium and to complement the first neutron monitor, DRBS. On completion, DRBS2 will be fully independent and able to replace the old instrument upon its retirement or failure. The design and development of the neutron monitor aims at the achievement of a prolonged exploitation period, high count rate and sensitivity to solar modulation, reliability and consistency of the measured data. To achieve this and to be able to extrapolate the observations from the first monitor it is important that the two monitors operate together under various geomagnetic and solar activity conditions for a considerable time period.

Design and Construction

The design of the monitor is based on a standard super monitor. It will have 9 detector tubes type LND 2061 filled with BF_3 gas. The detector tubes are placed into the structure of the reflector and the moderator in order to avoid neutrons from terrestrial origin and slow down the neutrons produced in the atmosphere. The response of the monitor has been modelled and optimized for the detection of neutrons resulting from the primary proton component of the galactic and solar cosmic rays. Study of the effect of the shape and dimensions of the components of the neutron monitor show that the reflector is of great importance in order to achieve a sufficient counting rate for proton source outside the atmosphere[1]. The neutron monitor was designed and is being constructed according to the obtained results.

Detailed description of the new neutron monitor is given in Fig. 1. The tubes are combined in sections of 3 independent units that are empowered by a separate high voltage power supply. This offers a certain redundancy and flexibility of operation. High quality commercial charge sensitive pre-amplifiers(CSA) are placed at the exit of the detector tubes to avoid noise and disturbances of the charge measurements. The signals from the CSA's are then fed to a prototype signal processing unit(SPU). The data acquisition is carried out by a Beaglebone Black computer that logs the counts at a custom rate and sends the results to a master file server. The real-time measurements will be available online on the website of the monitor (neutronmonitor.meteo.be).

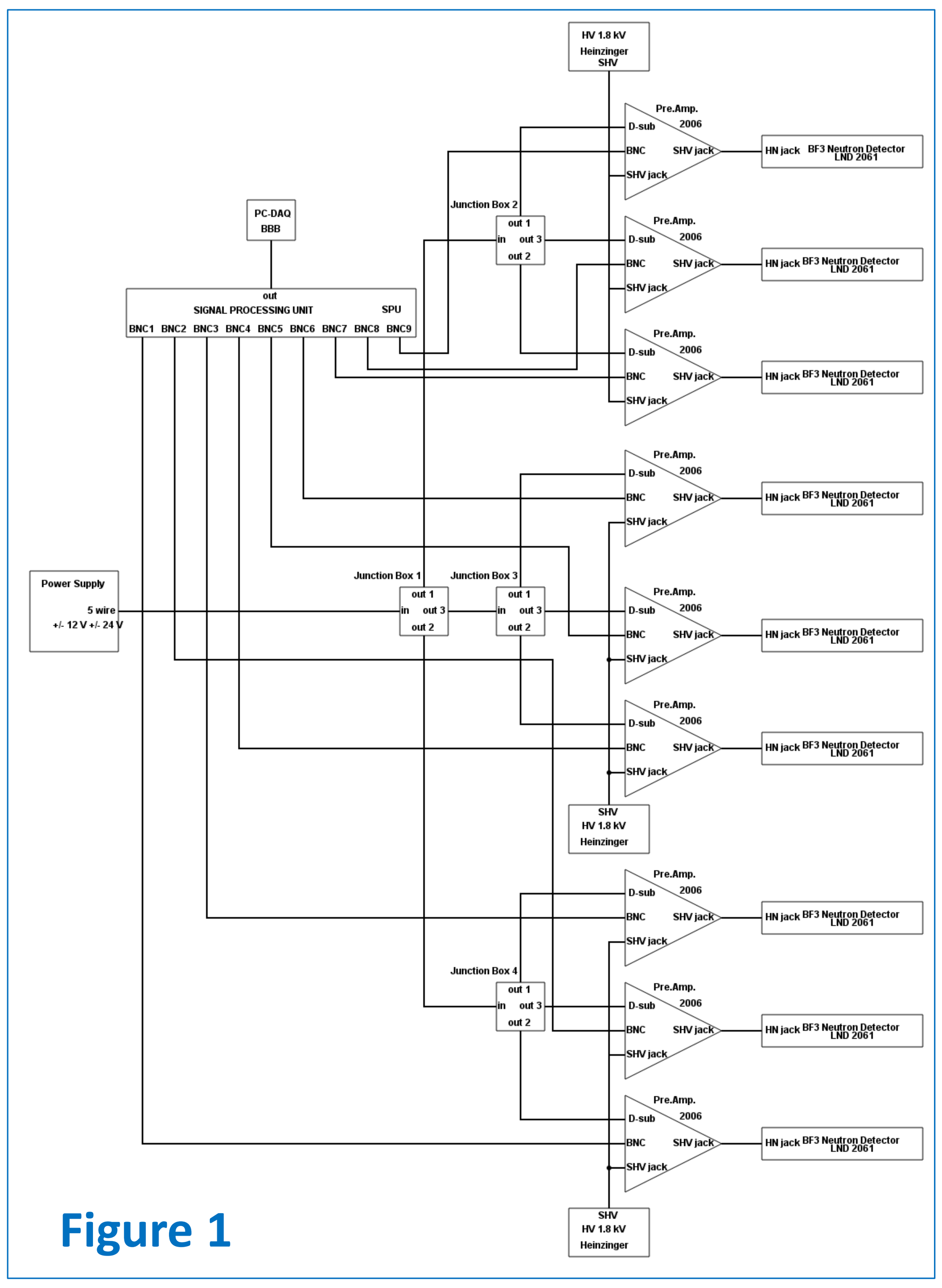

Figure 1

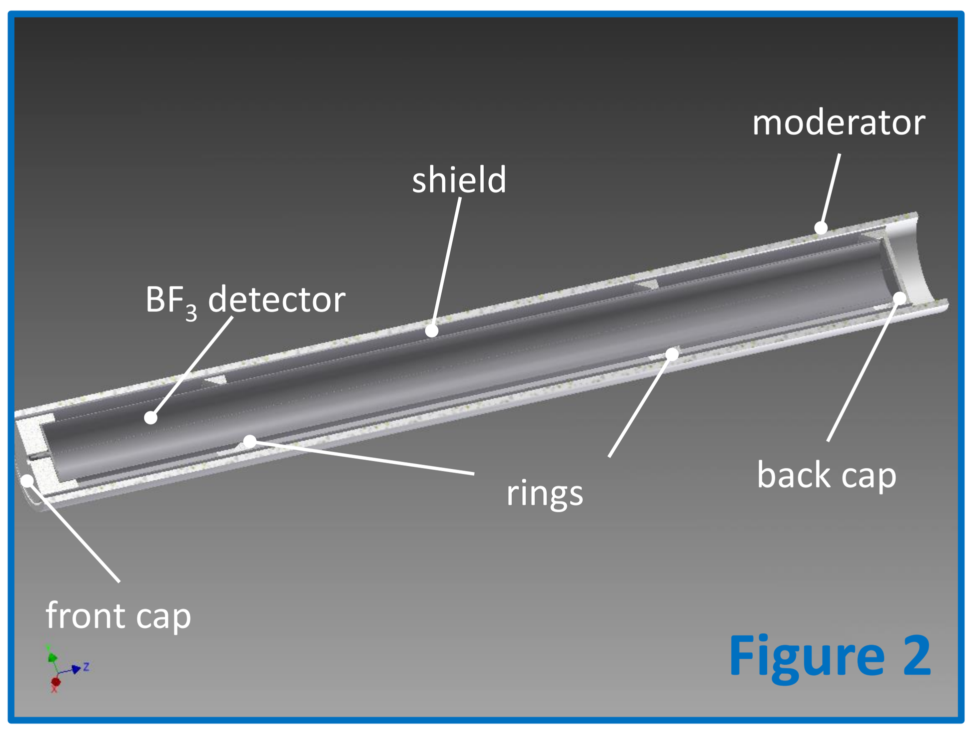

Figure 2

Detector, electrostatic shield and moderator

Each LND2061 tube is inserted into an aluminum tube serving as a high voltage protection and as an electrostatic shield of the detector tube to reduce any electrostatic noise and disturbances (Fig. 2). The tube has a female HN jack connector offering a better coupling and resistance to dust compared to the old BP-26 detector tubes. The projected operating voltage is 1.8 kV.

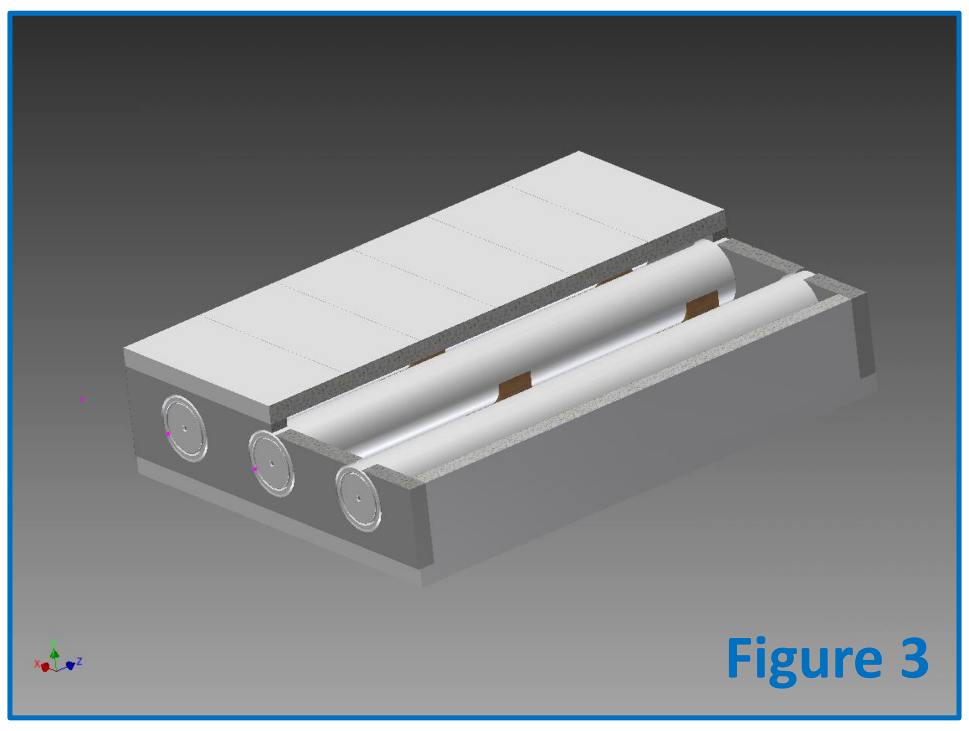

Figure 3

Monitor section and electronics

In Fig. 3 a section of three detector tubes is presented. Initially, the monitor will operate without a neutron producer. The sections have been designed to allow the addition of lead producers in a later stage. To position the detector assemblies, wooden (or high density polyethylene supports) will be used. The neutron moderator tube is optional and can be installed if necessary.

The three sections of the monitor will be placed in a separate location adjacent to the first monitor (Fig.4). Environmental control of temperature and humidity is foreseen. The instrumentation will be installed in a different building.

The Signal Processing Unit (SPU), consists of an active pulse shaper, low level discriminator and a matching step for the counting electronics. The discrimination level and the time constants of the SPU and therefore the values of the various components will be determined experimentally based on the output signal of a single detector tube and section. Based on the results of these experiments the nuclear electronics design will be finalized and the data acquisition will be implemented.

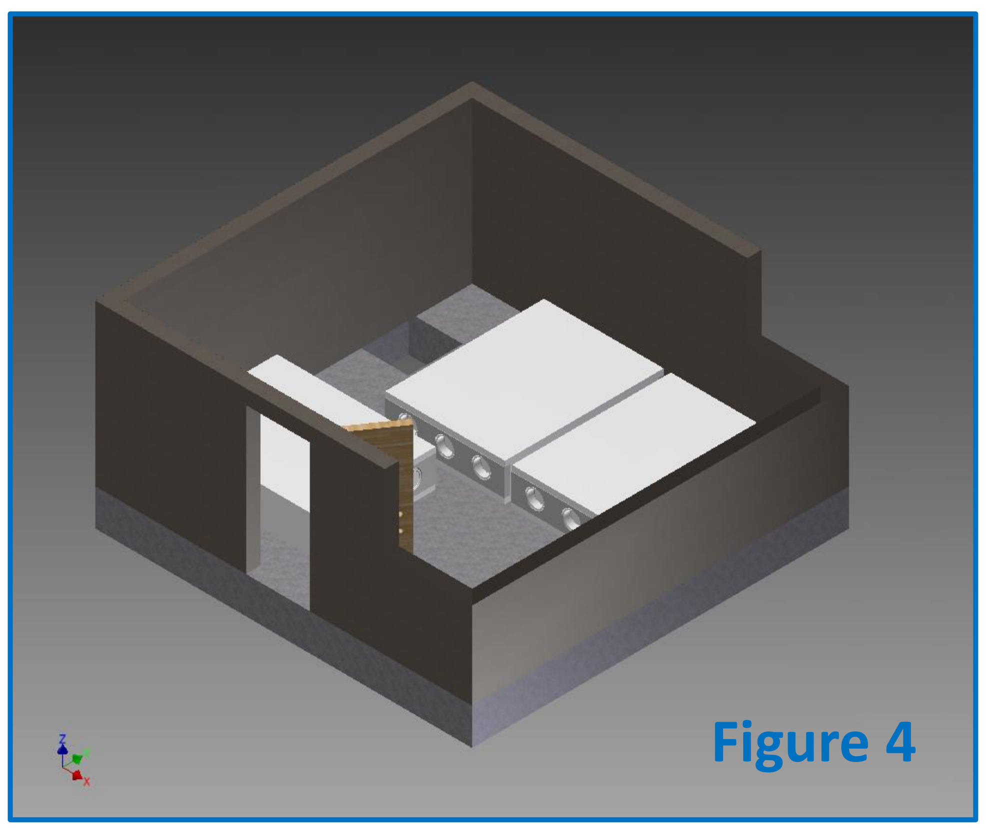

Figure 4

Present status and planning

The neutron monitor station will be built in 3 steps. During each step one section of 3 detector tubes will be constructed and connected to the data acquisition. The first section is almost completed and expected to be operational in the first months of 2017.

References: 1 *D.Sapundjiev, S.M.Stankov, J.-C. Jodogne, On the optimisation of the construction of a ground-based neutron monitor, ICRC2015,30 Jul - 6 Aug 2015, The Hague.*

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