The design of the portable spectrometers *Liulin-SET* is not new since similar devices have been flown in space since 1989 [Dachev *et al.,* 2015]. *Liulins* have been part of NASA's balloon flights from Fort Sumner, New Mexico with 3 *Liulin* battery operated units during the 8 June 2005 certification flight of the NASA Deep Space Test Bed (DSTB) balloon [Benton, 2005a, b]. The NASA RaD-X mission [Mertens, 2016] also flew a *Liulin* in September 2016. Similar instruments to the *Liulin-SET* were flown inside the ESA Biopan-5/6 facilities on Foton-M2/3 satellites [Häder *et al.,* 2009, Damasso *et. al.,* 2009]; the ESA EXPOSE-E/R/R2 platforms [Dachev *et al.,* 2012, 2015, 2017] and inside the BION-M No1 and Foton-M No4 satellite.

The existing state-of-the-art for real-time LET measurements is the Space Research and Technology Institute (SRTI), Bulgarian Academy of Sciences *Liulin-SET* (Figures 1 and 2) [Dachev, *et al.,* 2015] that fits within the *ARMAS ISS* module on the baseplate right side. The *Liulin-SET* uses 28 VDC and has an insulated DC/DC converter for transforming 18-36 V DC input to 12 V DC internal. A 3.0 V DC battery supplies power to the internal real time clock-calendar and is independent of the external power supply after the first initialization. The *Liulin-SET* spectrometer external view is shown in Figure 1. Its footprint dimensions are 4.3 × 7.8 cm with a total mass is 0.16 kg. The top panel is lightweight and has been milled from the backside to 0.5 mm aluminum allowing measurement of outer belt relativistic electrons.

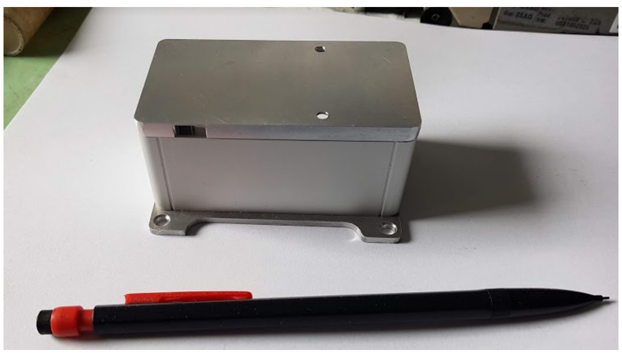

Fig. 1. Outside cover of the *Liulin-SET* for ISS with an aluminum housing.

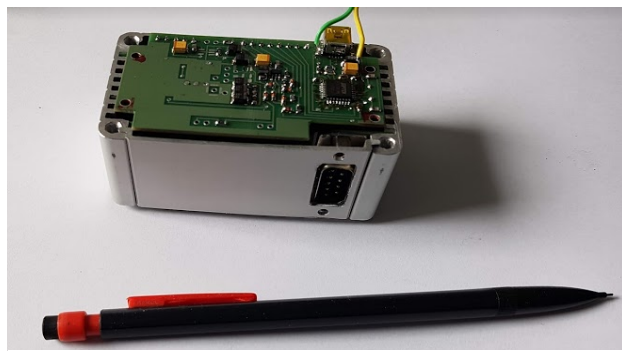

Fig. 2. Inside cover of ISS *Liulin-SET* that fits on right side of the ARMAS ISS baseplate.

The *Liulin-SET* spectrometer-dosimeter contain one silicon-PIN diode of Hamamatsu S2744-08 type (2 cm^2 area and 0.3 mm thickness), one ultra-low noise charge-sensitive preamplifier of AMPTEK A225 type, 2 microcontrollers, 32 MB flash memory. After passing a charge-sensitive preamplifier, the signal is digitized by a 12-bit fast analog to digital (A/D) converter. The doses (deposited energies) are determined by a pulse height analysis technique and then passed to a discriminator. According to AMPTEK A225 specifications the pulse amplitudes, A[V] are proportional by a factor of 240 mV/MeV to the energy loss in the detector and respectively to the dose. The amplitude of each signal from the income particles and quanta are transformed into digital signals, which are sorted into 256 channels by a multichannel analyzer. For every exposure interval, a single 256 channels energy deposition spectrum is collected. The energy channel number 256 accumulates all pulses with amplitudes exceeding the maximal level of the spectrometer of 20.83 MeV. All pulses in the 256^{th} channel are considered equal to the minimum energy level for this channel and were added to the dose calculation. Using statistics of about 2.5 million 10-s data points from the R3DE instrument flown in 2008–2009 on ISS, 1 event in the 256^{th} channel occurred once per 6.2 h of measurements on average.