INTRODUCTION

EUSO-Balloon is a balloon-borne experiment developed by the JEM-EUSO consortium. Its aim is to test the technologies and methods used in the forthcoming main experiment, EUSO-Balloon, as the main mission, is an imaging UV telescope. As the main mission, will have an IR camera to analyze the atmospheric properties along the balloon flight.

The IR Camera is a stand-alone subsystem within the balloon, which provides images centered at 10.8 µm and 12 µm (medium infrared), thanks to a ULIS UL 0471 microbolometer and two filters centered in that wavelengths with 0.85 µm of bandwidth [1]. The camera module is the IRCAM-640 developed to handle the microbolometer. It incorporates a shutter control.

The objectives of the IR camera are:
• To validate the JEM-EUSO IR camera mission concept.
• To obtain real data with µbolometer detector.
• To assess the wavelength bands and filters selection.
• To validate and optimize the retrieval algorithms.
• To validate and optimize stereo vision technique.
• To validate and assess part of calibration strategy.
• To validate and optimize temperature retrieval algorithm.

The ULIS detector is an infrared opto-electronic device sensitive to radiation in the long wave spectral range. It includes a microbolometer Focal Plane Array (FPA) comprised of a 640 × 480 pixels. The pixel pitch is 25 µm by 25 µm.

For the camera optics we decided to acquire a SURNIA Lenses equipment from the company Janos Technology. The filters define two bands. The first band covers from 9.4 to 10.8 µm (long near infrared), thanks to a NUCLEA company filters centered at 10.8 µm and 12 µm, and the second band covers from 12 to 12.425 µm [2].

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The EUSO-Balloon IR Camera took one picture every 80 seconds during the balloon flight held in August, 2014, over Timmins (Canada) [3]. It was functioning for around 17 hours, and therefore, took an overall of 753 photos. Although the EUSO-Balloon splashed down on a lake, the IR camera is water-proof, so all the data could be recovered. Due to the perfect isolation, the device is still perfectly working and the internal pressure only decreased to 1.3 bars. Moreover, after the flight the battery pack was still half charged.

Seven out of the 17 hours, the camera was functioning under water. Then, around 400 photos must be discarded from our analysis. If we take into account that the EUSO-Balloon conditions were not completely stable during the take off and landing, and we only consider for our study the photos taken during the proper flight (from around 03:30 to 8:20 UTC), 220 photos need to be analyzed.

Once the analysis of the images is completed and brightness temperature is retrieved of IR-camera, the Cloud Top Height (CTH) is established using a Weather Research and Forecasting model [4]. Vertical profiles of temperature and humidity are obtained for different locations and at different times covering the whole of EUSO-Balloon track. Thus, an algorithm is built: obtaining the cloud top height in each pixel of IR- Camera. To assess the fit of the model firstly we have compared the vertical profiles of the WRF with adjacent radiosondes and subsequently, CTH retrieved by the algorithm is compared with those provided by other satellites flying over EUSO- Balloon track. Also, some information related to the atmospheric optical depth can be obtained with the IR camera data [5].

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References:

Table 1

<table>
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<th>Current (A)</th>
<th>Voltage (V)</th>
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<tbody>
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<td>0.15</td>
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<tr>
<td>IR camera</td>
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<tr>
<td>Heaters (2 × 4W)</td>
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<td>DC-DC (12V)</td>
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<td>DC-DC (5V)</td>
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<td>0.15</td>
</tr>
<tr>
<td>Total</td>
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<td>-</td>
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</table>

Figure 1: ULIS UL-04-17-1 microbolometer.

Figure 2: Scheme of the IRXCAM-640 camera module and SURNIA optics.

Figure 3: Some IR camera devices (current converter, SSD, IR camera module and the electronic).

Figure 4: The battery pack together with all the IR camera devices.

Figure 5: Image taken by the IR camera during the balloon flight.