PROCEEDINGS OF SCIENCE

The quick look subsystem of the GRASS-2 Experiment

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In this paper we briefly report on the quick look and data management subsystems developed by IAPS/INAF for the GRASS-2 [1] experiment funded by the HEMERA [2] program.

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1. The GRASS-2 experiment

GRASS-2 (fig. 1), is a small gamma ray detector system designed for the measurement of atmospheric and cosmic background parameters in the stratosphere. The main component of the system is the device "ArrayC-60035-64P" [3], an array of 64 small square scintillation detectors paired to a 64 pixel silicon photomultiplier (SiPM, fig. 2). Relying on a coded mask, this detector, has good spatial resolution and imaging capability.

Figure 1: Grass-2 ready to fly

Silicon photomultiplier detectors have already proven useful in satellite missions such as INTEGRAL [4] and Swift [5]. This technology will support the development of more compact and lighter imaging spectrometers. In particular, it will be possible, to detect and position rapidly changing celestial sources, such as gamma-ray bursts, gravitational waves and neutrino counterparts.

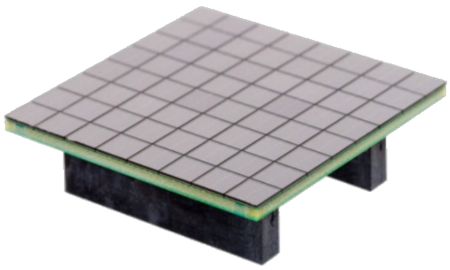

Figure 2: The C-60035-64P array (8x8)

2. Stratospherical balloons

The GRASS-2 experiment was launched from the Timmins base (Canada) on August 12, 2022; the instrument has been taking data for 11.5 hours reaching the maximum altitude of 32.5 km. Stratospherical balloons (fig. 3), are high-altitude balloons released into the stratosphere. They are operated in the region from 15 to 45 km in altitude equipped with possibly several gondolas suspended on the flight chain. Gondolas can carry payloads weighting up to 1.1 tons.

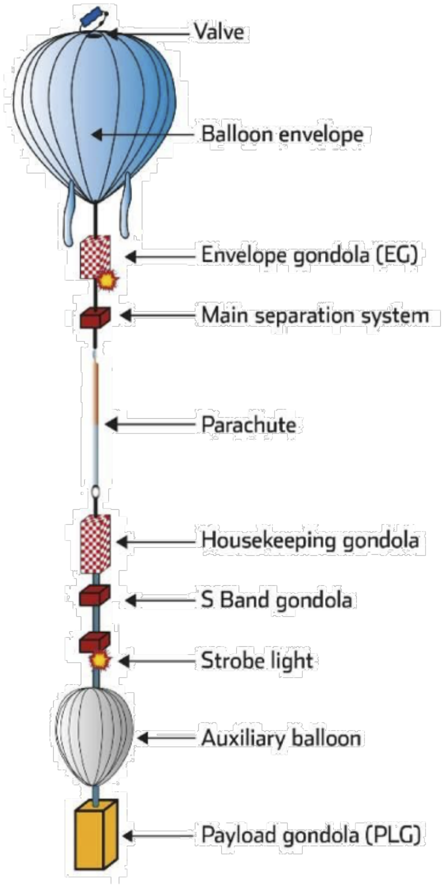

Figure 3: Flight chain schematic

These balloons can be used to to test scientific instruments and for short-term measurement campaigns for far less than the cost of a satellite. They can flight for days, weeks, and even months, requiring no engine and no fuel and can be recovered after each mission.

3. Payload and communication highlights

The payload was hosted on board of Carmencita [6] (fig. 4), a multi-payload gondola released by CNES in late 2012, and launched from the Canadian base of Timmins on August 12, 2022. Communications to and from the payload where managed by PASTIS [7], with its ground and on-board modules (fig. 5), a flight subsystem by CNES devoted to the control and monitoring of payloads. PASTIS guarantees the communication between the ground station and the payloads through an ethernet link. To control SiPMs only one driver has been developed for Windows, which therefore, inevitably, was chosen as the on-board operating system. The communication between the payload and the ground was implemented by scp/sftp, a network protocol particularly suited to the needs of the experiment, made available by the Windows Linux Subsystem.

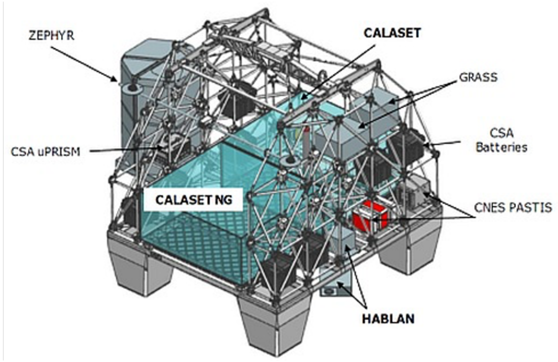

Figure 4: Carmencita

The whole hardware system is controlled by an industrial single board computer UDOO running the software environment.
To save energy, during inactivity times, the system stood-by and was awakened by Wake On Lan packets (magic packets) sent on the internet link.

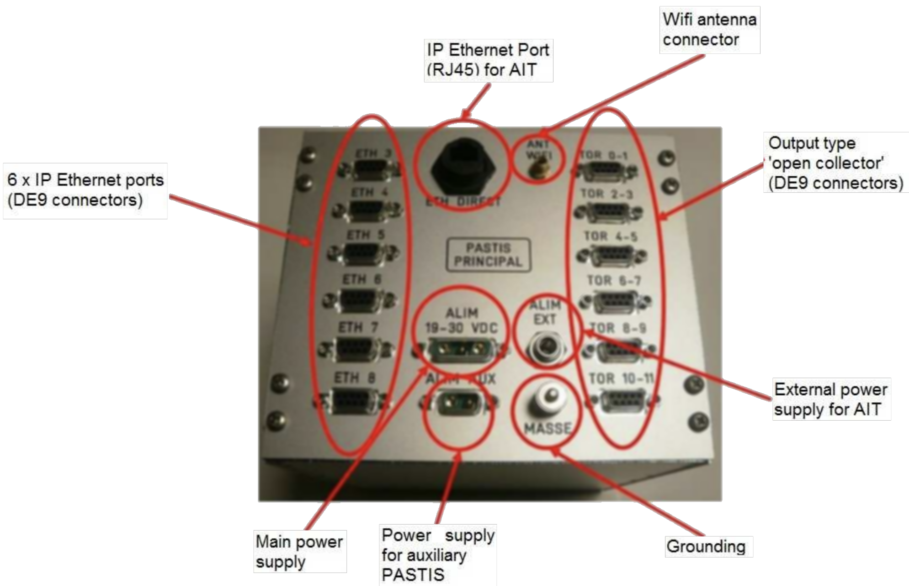

Figure 5: PASTIS on-board module

4. Flight control

GRASS-2 is controlled by a user graphical interface running on a Control Console (fig. 6). Through this interface, during the flight and according to the behavior of the detector, it is possible to acquire and/or modify the instrument operating parameters, e.g. the preamplifiers gain or their trigger levels, in order to optimize its effectiveness.

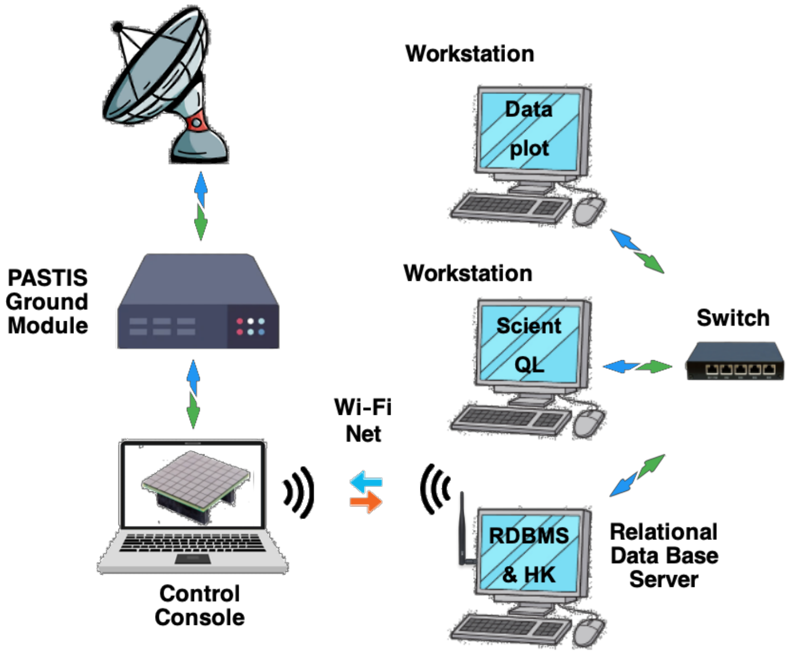

Figure 6: Flight control schematic

Requests for acquisition or modification of parameters are sent through the graphic interface to the PASTIS ground module and from this transferred to the corresponding on-board component.
For security reasons the ethernet link connecting the graphical interface and the PASTIS ground module for security reasons has been made not reachable by other devices.
The console transfers the collected housekeeping and scientific data to a relational data base server where they are organized into functional homogeneous tables through an ad-hoc WiFi net, thus solving both the problems of concurrent access to data and that of an effective querying.
This server makes these data available to other working stations which are mainly in charge of the experiment quick look (housekeeping fig. 7 and scientific fig. 8 and fig. 9 data reporting in real time).

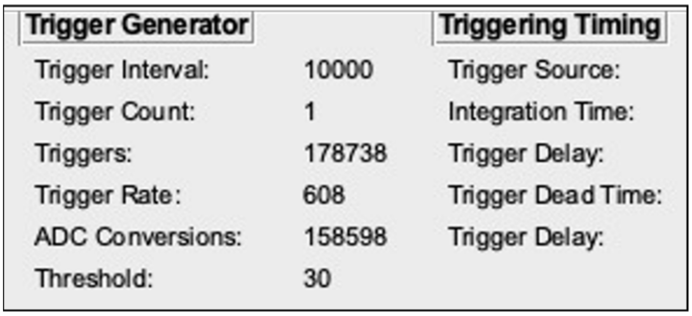

Figure 7: A housekeeping example

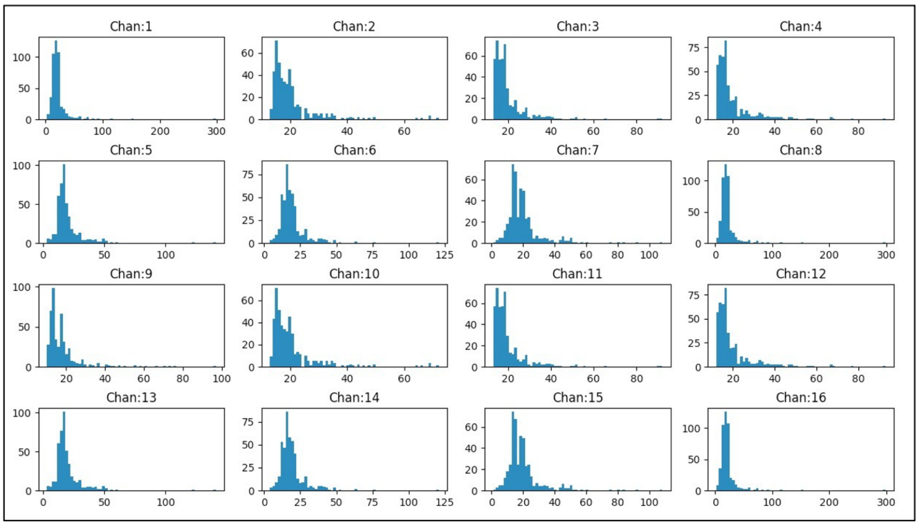

Figure 8: ADC channels data

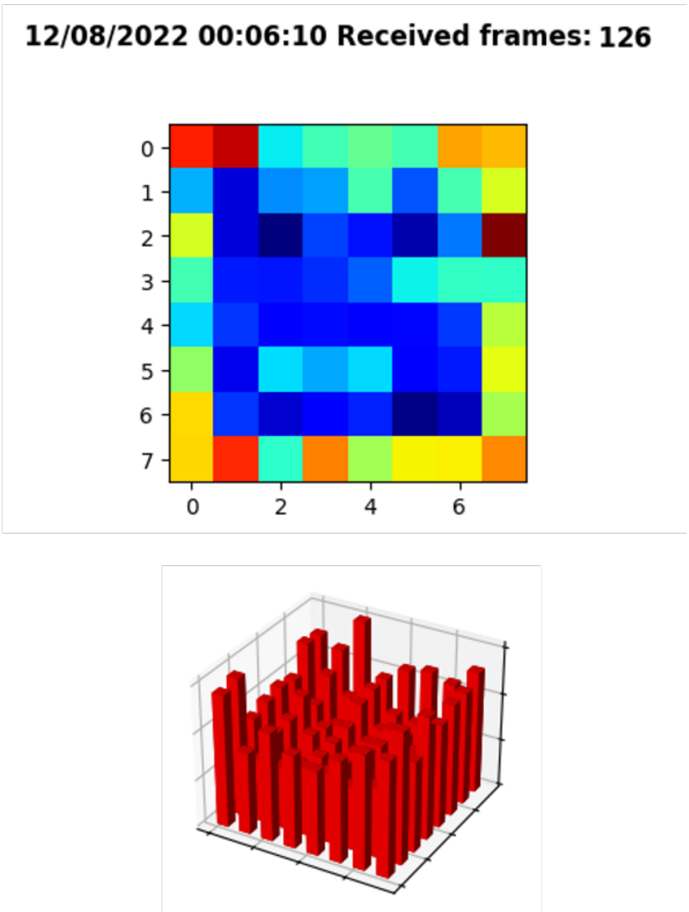

Figure 9: Reconstructed image data

5. Future developments

We plan to bypass the driver provided for the SiPMs management by directly accessing the device registers to program the electronics behavior and read ADC's content. We would also like to improve the quality of the graphic section relying on the functionality offered by Grafana [8]. Grafana makes it possible to unifying various data sources for display on special panels or dashboards by easily interconnecting with mySQL databases. Furthermore is an open source web application providing charts, graphs, and alerts for the web.

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