Contribution ID: **47** Type: **Poster presentation**

ELECTRONICS FOR HARPO - Design, development and validation of electronics for a high performance polarized gamma-ray detector

Friday, June 10, 2016 10:30 AM (1h 35m)

HARPO (Hermetic ARgon POlarimeter) is an R&D program to characterize the operation of an argon-gas-based TPC (Time Projection Chamber) as a high-angular-resolution and sensitivity telescope and polarimeter for cosmic γ-rays in the energy range MeV – GeV. The present demonstrator is aimed at ground-validation tests, but we have designed it taking into account the constraint of space operation. Indeed, γ telescopes currently in orbit suffer from a lack of sensitivity in the lower part of the γ-ray energy spectrum due to the technology they use (Si detector / W converter combinations) and the inefficiency of the trigger to distinguish events from the background noise in this energy range.

HARPO produces very fine 3D images of γ-conversions to e+ e− pairs by tracking these events. This is done at a low cost in terms of power consumption and data flow in the presence of a large number of background noise tracks.

The TPC is a 30 cm cubic field cage, enclosed with a copper cathode and a readout plane anode including a multi-stage amplification system (two GEM + MICROMEGAS). The signal is collected by two orthogonal series of strips (x & y), which, in our case, reduces the number of channels by a factor 144 compared to the equivalent pixel sensor. This reduction is only possible if the channel occupancy is low enough to avoid unsolvable ambiguities and comes at the cost of the need for off-line association of each x track to a track in the y view. Then, only 576 channels (x & y strips, 1 mm pitch) are read out and digitized at 33 MHz (up to 100 MHz) by eight AFTER chips mounted on two FEC boards. Channel data are then zero suppressed and sent to a PC via Gigabit Ethernet by two FEMINOS boards synchronized by one TCM board. These versatile boards were originally developed at IRFU for the T2K and MINOS experiments. To mitigate the dead time induced by readout and digitization (1.6 ms) we developed a sophisticated trigger, with a multi-line system so as to provide real-time efficiency monitoring. This trigger suppressed the huge background rate from the accelerator (up to 5 kHz) by a rejection factor greater than two orders of magnitude during the data taking campaign at NewSUBARU (Hyôgo, Japan) in 2014.

Preliminary results demonstrate that the design of a space TPC is viable, based on a reduction of the number of channels by several orders of magnitude (at the price of more sophisticated hardware and software) and on a scheme that enables event reconstruction with an excellent resolution and that is immune to the presence of additional background tracks. The next step will be the design of a balloon-borne TPC, in particular its trigger, which is a key point for a successful space telescope. That trigger will have to extract approximately 10 Hz photon conversion signal from about 5000 Hz single-track background.

Primary author: GEEREBAERT, yannick (LLR, Ecole Polytechnique, CNRS/IN2P3, France)

Co-authors: TAKEMOTO, Akinori (LASTI, University of Hyôgo, Japan); DELBART, Alain (Irfu, CEA-Saclay, France); GIEBELS, Berrie (LLR, Ecole Polytechnique, CNRS/IN2P3, France); ATTIÉ, David (Irfu, CEA-Saclay, France); BERNARD, Denis (LLR, Ecole Polytechnique, CNRS/IN2P3, France); CALVET, Denis (CEA/IRFU, Centre de Saclay (FR)); GÖTZ, Diego (AIM, CEA/DSM-CNRS-Université Paris Diderot, IRFU/Service d'Astrophysique, CEA-Saclay, France); OHKUMA, Haruo (JASRI/SPring8, Japan); DEIRDRE, Horan (LLR, Ecole Polytechnique, CNRS/IN2P3, France); SEMENIOUK, Igor (LLR, Ecole Polytechnique, CNRS/IN2P3, France); LOUZIR, Marc (LLR, Ecole Polytechnique, CNRS/IN2P3, France); YAMAGUCHI, Masashi (LASTI, University of Hyôgo, Japan); POILLEUX, Patrick (LLR, Ecole Polytechnique, CNRS/IN2P3, France); SIZUN, Patrick (Irfu, CEA-Saclay, France); COLAS, Paul (Irfu, CEA-Saclay, France); GROS, Philippe (LLR, Ecole Polytechnique, CNRS/IN2P3, France); HASHIMOTO, Satoshi (LASTI, University of Hyôgo, Japan); DATÉ, Schin (JASRI/SPring8, Japan); WANG, Shaobo (LLR, Ecole Polytechnique, CNRS/IN2P3, France); AMANO, Sho (LASTI, University of Hyôgo, Japan); MIYAMOTO, Shuji (LASTI, University of Hyôgo, Japan); KOTAKA, Takuya (LASTI, University of Hyôgo, Japan); MINAMIYAMA, Yasuhito (LASTI, University of Hyôgo, Japan); FROTIN, mickaël (LLR, Ecole Polytechnique, CNRS/IN2P3, France); BRUEL, philippe (LLR, Ecole Polytechnique, CNRS/IN2P3, France)

Presenter: GEEREBAERT, yannick (LLR, Ecole Polytechnique, CNRS/IN2P3, France)

Session Classification: Poster Session 2

Track Classification: Data Acquisition