Camera Control and Central Control of the MAGIC Telescope

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Abstract

The 17 m diameter IACT MAGIC is currently in its commissioning phase. The control system of the telescope is distributed over a number of functional elements: a FADC-based data acquisition, a subsystem responsible for the calibrations and the elements inside the camera, a drive system, a two level trigger, an active mirror control, a star guider, a camera oscillation monitor and other auxiliary elements. CANbus is favoured for the communication with the hardware. A central PC steers all these subsystems over ethernet and allows a human operator full control over the telescope. Here we describe the central control and camera/calibration control subsystems.

1. Introduction

MAGIC[1,2] is a new generation Imaging Air Cherenkov Telescope (IACT) located at the IAC site in the Canary island of La Palma. The telescope commissioning phase is well advanced and MAGIC shall become fully operative during summer 2003. The aim of this paper is to review the features of the Central Control system of the telescope and the Camera/Calibration Control as well.

2. Central Control of the telescope

The control system of the telescope is split up into functional units which correspond to the independent subsystems of the telescope. A central control computer coordinates all the subsystems and provides the user interface during normal observations. The most important subsystems are listed below:

- Data acquisition system based on 577 FADC channels and designed to acquire up to 1 kevent/s. An online monitor and an online analysis program will run over the data online.

pp. 2931–2934

- Camera and calibration of the camera, described in the next sections.
- Drive system: it steers 2 synchronized motors on AZ and 1 on ALT and monitors the telescope position using 2 shaft encoders and 2 rotary encoders over CANbus.
- Level 2 trigger: a VME system -controlled by a VME CPU- allows online loading of new trigger tables. Events can be pre-scaled to optimize event recording at low energies and perform online gamma/hadron separation.
- Active Mirror Control: two motors behind each 1m^2 mirror panel allow to correct any reflector deformation (stepping motors, custom motor steering electronics, CCD and laser pointer).
- Star Guider and Camera Oscillation Monitor using 2 CCDs.

The operator has access to all the subsystem functionalities from a central PC which steers all the subsystems over 100 Mbit/s Ethernet (custom communication protocol over TCP/IP). No subsystems are interconnected. The central control software is written in Labview 6i. In future, a (foreseeable Oracle) data base will store the configuration information and control output data.

3. The MAGIC Camera

The Camera is a decisive element for improving the gamma sensitivity and the gamma/hadron separation. A finer pixelized camera has been designed and constructed at IFAE and it was installed at the telescope in November 2002. The Camera has the following features:

- 1.5 m diameter and ∼500 Kg weight (∼4° FOV).
- Inner hexagonal area of 396 PMTs (ET 9116A) of 1" diameter, equivalent to 0.1° FOV each, surrounded by 180 PMTs (ET 9117A) of 1.5" diameter, equivalent to 0.2° FOV. Typically, response FWHM below 1 ns. [3,4]
- Hemispherical bialkali photocathode PMT coated with a special lacquer that enhances the QE up to 30% [5]. Single photoelectron response.
- Ultrafast and very low-noise transimpedance pixel pre-amp, zener stabilized HV 6-dynode distribution system with an active load. [6]
- Dedicated Light Collectors -designed by MPI- that maximize, at large incident photon angles, the number of photon trajectories that cross the hemispherical photocathode twice.
- HV Regulators for each PMT fully covering the 0-2000 V range.

- Readout of DC currents and HV: every 96 pixel values are multiplexed and digitized by a 12-bit ADC.
- Water-based cooling system with temperature/humidity sensors.
- Optical transmitters of analogue signals using VCSELs (Vertical Cavity Surface Emitting Laser).

4. The Camera Control

The Camera Control is based in the same concept of the Central Control system: every functionality in the camera is controlled by independent camera subsystems which are managed by a "central" Camera Control. From the technical point of view, the control system is implemented in a Linux PC and it consists of two layers of software developed using two different programming languages:

- C/C++ for communication with the hardware.
- Labview 6.i for the Graphical User Interface and Camera Control operation.

All the functionality of the camera is controlled by accessing the hardware with several communication buses and protocols. Those buses and the related functionality are listed below:

1. **CANbus:** The communication with the hardware is mainly performed through 2 CANbus lines (Janz CAN_PCI2/1O Card) of about 200 meters length with a total of 16 nodes.

   Both lines are used to have control over every pixel in the camera for:

   - Regulation and monitoring of the High Voltage.
   - Monitoring of the pixel DC currents.

   CANbus is also used for the control of several devices which have serial port access, by using CANbus to RS-232 converters (IXXAT CANlink module):

   - the Remote control of the High Voltage power supply.
   - the Setting of the discriminator threshold.

2. **RS-485:** The control of the Cooling, Lid and Low Voltages of the camera have been implemented in an autonomous way using 2 PLCs (Programmable Logic Controller). The access to those PLCs is done using the Modbus protocol over 2 RS-485 lines (Meilhaus ME-9000/4 PCI Card) of about 200 meters length.

This autonomous control allows, for instance, the Cooling subsystem to regulate standalone the temperature inside the camera to avoid water condensation and to ensure constant temperature during operation.

The Camera Control system data flow is saved to tape together with all the information from the other systems.

5. The Calibration Control

The Calibration system of the telescope is described in detail at M.Gaug et al. contribution to these proceedings[7].

The calibration system elements are accessed and controlled through CAN-bus, allowing to set the desired calibration configuration. The Calibration system is triggered from the Camera Control by an ECL line. In this way, the calibration of the telescope is fully automatized.

6. Conclusions

The MAGIC Telescope is in commissioning phase. Both the Camera and Calibration systems have been functional since March 2003. The cooling system was installed in November 2002 and until now it has responded successfully. More detailed results on the performance of the control system will be presented in this conference.

Acknowledgments

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