The Control System of the MAGIC telescope

J. Cortina, E. Domingo, J. Flix, J. López, M. Martinez
Institut de Fisica d'Altes Energies,
Edifici Cn Universitat Autonoma de Barcelona,
08193 Bellaterra, Spain.
for the MAGIC collaboration.
Updated collaborator list at
http://hegra1.mppmu.mpg.de/MAGICWeb/collaborators.html

Abstract

The 17 m diameter IACT MAGIC will be commissioned during this year. The control system of the telescope is distributed over a number of functional autonomous elements. CANbus is favored 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 mainly focus on the Central Control and Camera Control systems.

1. Introduction

MAGIC[1] is a new generation Imaging Air Cherenkov Telescope (IACT) allocated at the IAC site in the Canary island of La Palma. The aim of the telescope is to detect very high energy photons covering the energy range above 30 GeV, exploring the unobserved 20-200 GeV energy range. The telescope incorporates several new technical features, which have been never used in Imaging Air Cherenkov Telescopes beforehand. These features are explained in more detail in the "Status of the MAGIC Telescope" contribution to these proceedings by E. Lorenz.

The aim of this paper is to review the Central Control system of the telescope as the Camera Control as well. But it should be remarked that the physics potential is wide and covers many subjects as AGNs, SNRs, pulsars, gamma-ray bursts, cosmology, dark matter searches, fundamental physics, etc.

The telescope is entering now in its commissioning phase and shall become operative, by means of full data taking, in mid of year 2003.

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2. Central Control of the telescope

The control system of the telescope is split up into functional units which corresponds 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 (figure 1) are listed below:

- Data acquisition system (see MAGIC DAQ contribution to these proceedings) 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.

- Camera and calibration of the camera.

- Drive system: it steers 2 ALT/AZ motors 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 (custom-motor motor steering electronics, CCD and laser pointer).

- Star Guider and Camera Oscillation Monitor using 2 CCDs.

- Auxiliary PC: GRB alarm, weather station, GPS reference and future NSB detectors.

- LIDAR: an independent optical telescope equipped with a laser to monitor the light attenuation in the atmosphere.

- Optical telescope: aimed UBVRI photometry down to 18m with 0.01m accuracy, 20-30 FOV (AGNs, pulsars, μQSR).

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.

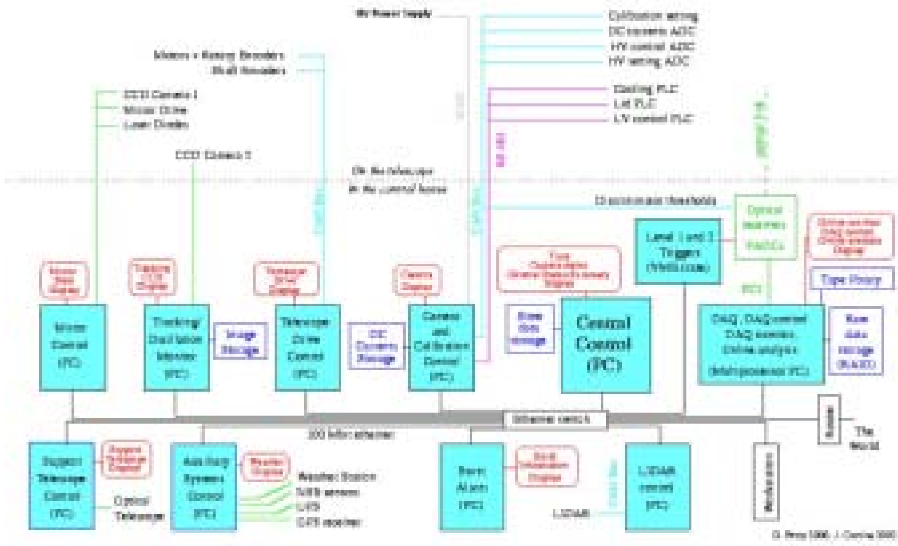

Fig. 1. Outline of the MAGIC control system.

3. The MAGIC Camera

The Camera is a decisive element for improving the gamma sensitivity and the gamma/hadron separation. A finner pixelized camera (figure 2) has been designed and constructed at IFAE, consisting of:

- 1.5 m diameter and ∼500 Kg weight (∼4^o FOV).
- Inner hexagonal area of 397 0.1^o FOV PMTs of 1" diameter (EMI 9117A) surrounded by 180 0.2^o FOV PMTs of 1.5" diameter (EMI D567B). Typically, response FWHM below 1 ns. [2]
- Semi spherical PMT photocathode with QE up to 30%, is coated with a WLS that enhances their response to UV light. Single photoelectron response. [3]
- Ultrafast and very low-noise transimpedance pixel pre-amp, zener stabilized HV 6-dynode distribution system with an active load. [4]
- Dedicated Light Collectors let double photon crossing in the PMT photocathodes for large acceptance angles.

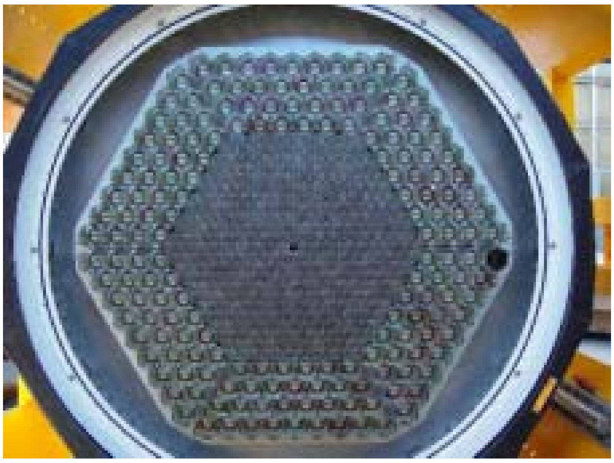

Fig. 2. Front view of MAGIC Camera.

- HV Regulators for each PMT fully covering the 0-2000 V range (two external HV power supplies).
- The Cooling system is water based with shielded fans and temperature/humidity sensors.
- Instrumented Camera lid.
- Readout of DC currents and HV: every 96 pixel values are multiplexed and digitized by a 12-bit ADC.
- Optical transmitters of analogue signals using VCSELs. [5]

4. The Camera Control

The Camera Control is based in the same concept of the Central Control system. As it has been pointed out before it means that 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 (figure 3) and Camera Control operation.

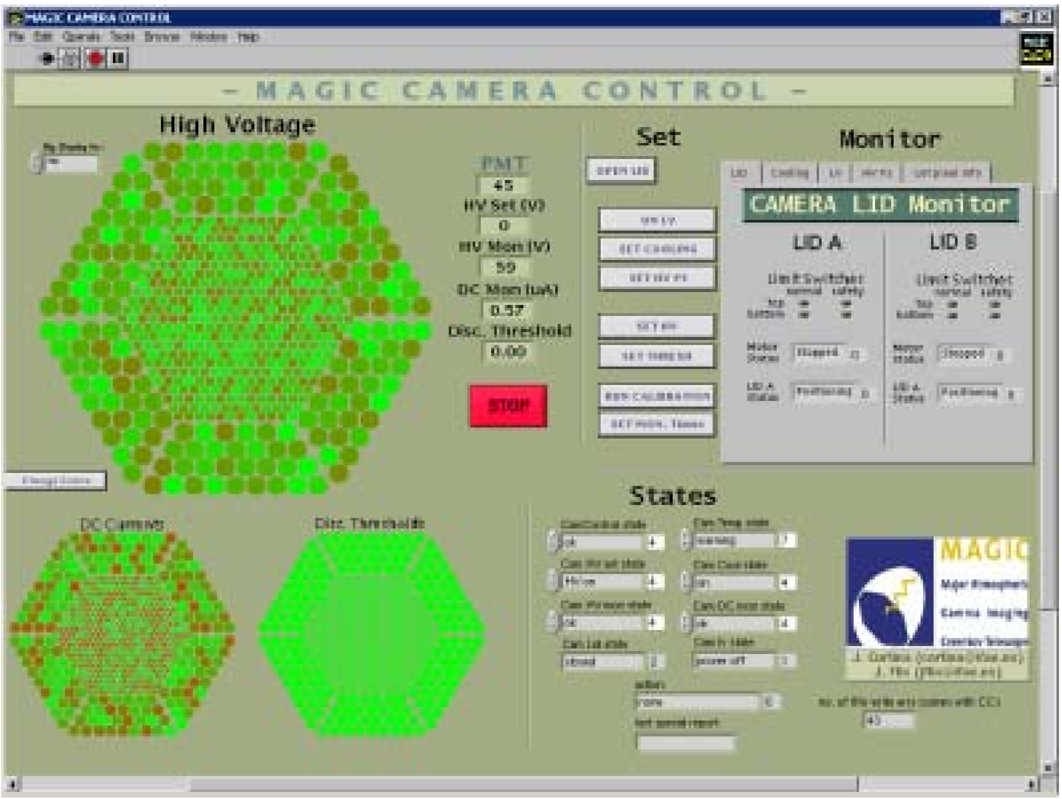

Fig. 3. GUI of the MAGIC Camera Control system.

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

1. RS-232.

   Remote control of the High Voltage power supply.

2. RS-485.

   The control of the Cooling, Lid and Low Voltages of the camera have been implemented in an autonomous way using several PLCs (Programmable Logic Controller). That means, for example, that the Cooling subsystem is able to regulate standalone the temperature inside the camera to avoid water condensation and to ensure constant temperature during operation ($\sim 30^o$ C).

   The access to those PLCs is done using an standard protocol over RS-485 called Modbus.

3. CANbus.

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

   - Regulation and monitoring of the High Voltage.
   - Monitoring of the DC current at 10 Hz.
   - Setting of the discriminator threshold.

The Camera Control system data flow is $\sim$ 22 KBytes/s which is saved to tape together with all the information from the other systems.

5. Conclusions

The MAGIC Telescope is in commissioning phase and first light is expected to happen in the beginning of the year 2003. The Central Control and the Camera Control are being installed and tested in La Palma. This system is going to be fully operative before data taking period in mid 2003.

Acknowledgments

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