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THE CONTROL SYSTEM OF THE MAGIC TELESCOPE

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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 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 mainly focus on the central control and camera control subsystems.

Introduction:

MAGIC[1] is a new generation Cherenkov telescope at the IAC site in the Canary island *La Palma*. The telescope is in commissioning phase and shall become operative at the end of year 2002.

The main characteristics are:

- 17 *m* ϕ disk in a ultra-light carbon fibre frame.
- ~950 50x50 *cm*^{2} aluminium Mirrors.
- Active mirror control.
- 577 pixel low-weight Camera, 4° FOV.
- Optical signal transmission (over ~150 *m*).
- Fast pulse sampling: 300 *MHz* FADC.
- Fast repositioning of telescope: ~30 *s*.
- Low E. threshold for γ detection: ~30 *GeV*.

The physics potential is wide and covers: AGNs, SNRs, pulsars, γ-ray bursts, cosmology, dark matter searches, fundamental physics, etc…

Control Architecture:

The control system consists of a central control computer and a number of almost autonomous sub-systems:

- Data acquisition system (see DAQ poster) 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 camera (see below).
- 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 γ/h 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 18^m with 0.01^m accuracy, 20'-30' FOV (AGNs, pulsars, μQSR).

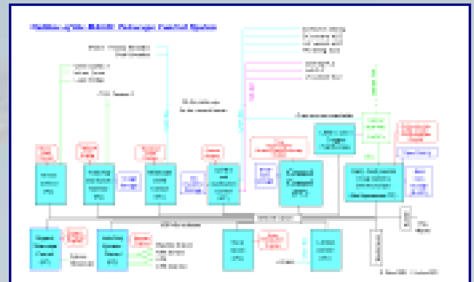

Fig.1: Outline of the MAGIC control system

Central Control:

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. A (foreseeably Oracle) data base will in the future store the configuration information and control output data.

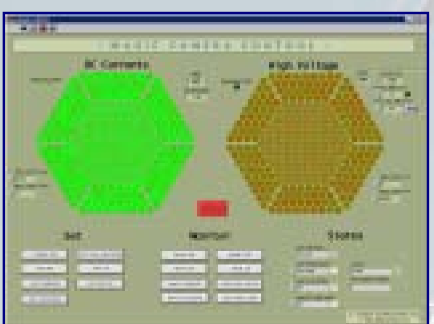

Fig.2: Capture of the Camera and Calibration Control GUI.

The Camera:

The Camera, constructed at IFAE, consist of:

- 1.5 *m* ϕ and ~500 *Kg* weight (~4 ° FOV).
- Inner hexagonal area of 397 0.1° FOV PMTs of 1'' ϕ (EMI 9117A) surrounded by 180 0.2° FOV PMTs of 1.5'' ϕ (EMI D567B). Typically, response FWHM below 1 *ns*. [2]
- Semi spherical PMT photocatode 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 photocatodes for large acceptance angles.
- 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 digitised by a 12-bit ADC.
- Optical transmitters of analogue signals using VCSELs. [5]

Fig.3: Camera front view

Fig.4: Camera rear view

The Camera Control:

Based in the same concept of the central control system of the Telescope:

- Every functionality in the camera is controlled by independent camera subsystems which are managed by a central Camera Control.

It is implemented in a Linux (Suse) PC. The software has been developed using different languages:

- C/C++: Communication with the hardware.
- Labview: GUI (fig. 2) & Camera Control operation.

Different communication buses and protocols are used to access the hardware:

- RS-232.
- RS-485 (Modbus to PLCs)
- CANbus.

Two autonomous PLCs for Cooling system, Camera lid and Low Voltages.

This Control system fully controls the functionality of the Camera:

- Remote control of High and Low Voltage power supplies.
- Temperature is controlled to avoid water condensation inside the Camera and to ensure constant temperature during operation (~30° C).
- Opening/Closing the Camera lid.
- For 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 subsystem outputs ~22 *KBytes/s* control data which is saved to tape with the FADC raw data.

References:

[1] The MAGIC Telescope, Design study for the construction of a 17m Cherenkov Telescope for Gamma Ray Astronomy above 10 GeV, Preprint MPI-PhE-98-5 March, 1998.

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