New control system for the IAC80 telescope

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Abstract*—*The IAC80 telescope, designed for optical observations, was fully conceived and built by the Instituto de Astrofísica de Canarias (IAC), becoming the first telescope of its class developed in Spain. Development began in 1980, and the telescope was installed at the Observatorio del Teide in 1991. In 2020, a feasibility study was carried out to upgrade the control electronics. The study concluded that, besides electronic and software upgrades, the telescope drive motors and encoders also needed replacement. The selected technology for the new control system was EtherCAT, using Beckhoff Automation equipment. Beckhoff motors were also chosen to ensure full compatibility and seamless integration between the control and motion systems. Tests of the new control system have been underway since 2025, with very promising results obtained so far. An important aspect of this upgrade is that it is being carried out without reducing the telescope's observing time, allowing scientific operations to continue uninterrupted.

Keywords*—*IAC80 telescope, EtherCAT, TwinCAT, PLCs

I. INTRODUCTION

The IAC80 Telescope is mounted on a German equatorial mount with an effective focal ratio of f/11.3, a focal length of 9.02 m, and a primary mirror diameter of 82 cm. Instrumentation is installed at the Cassegrain focus. Thanks to its versatility and high availability, the IAC80 plays a key role at the Teide Observatory and is currently equipped with the wide-field camera CAMELOT2.

Figure 1 shows the mechanical layout of the telescope. For the Right Ascension (R.A.) axis, the system implements three slewing speed modes depending on target distance, with motor speeds from 1.5 to 15 rps (90–900 rpm) and axis speeds from 3 to 30°/min. In tracking mode, the motor operates at 0.125 rps (7.5 rpm), ensuring smoother and more precise motion. For the Declination (Dec.) axis, motor speeds range from 1.5 to 10 rps (90–600 rpm), with axis speeds from 4.5 to 30°/min. Although higher accelerations enabled faster positioning, the parameters were later reduced because backlash and possible motor power losses could lock the system. Consequently, the telescope operates at relatively low slewing and tracking speeds. Resonances detected in 1995 also required careful motor-driver tuning and the installation of dampers to ensure stable operation.

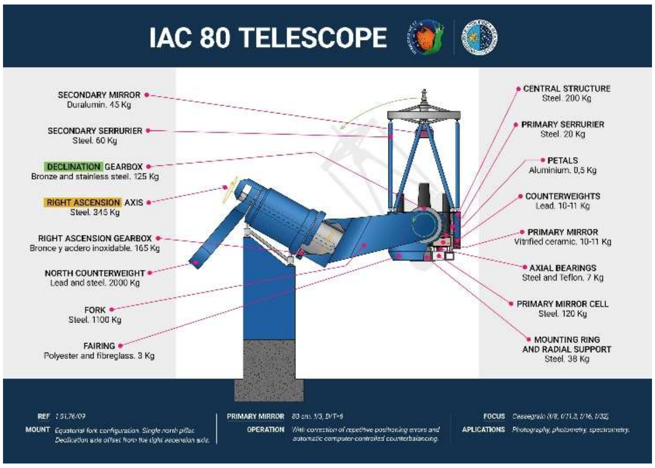

Fig 1 Illustrates the mechanical system of the IAC80 Telescope

II. OVERVIEW OF THE OLD CONTROL SYSTEM

As shown in Figure 2, the original IAC80 control system was centred on the Control PC, which managed all telescope operations and communicated with the different subsystems mainly through RS-232 serial links and digital I/O interfaces. Due to its limited computing capabilities, several auxiliary computers were integrated into the system: the User PC provided the user interface, the FOVIA PC processed guiding camera signals and generated tracking corrections, and the Instrument PCs allowed instruments such as CAMELOT2 and FastCam to perform telescope operations, including pointing and focusing.

The Control PC processed commands from all these systems uniformly, without distinguishing their origin. Additional subsystems included a GPS receiver for Universal Time (UT) synchronization, required for accurate pointing calculations, and a weather station for environmental monitoring. The GPS communicated with the Control PC through a dedicated PC03XT interface card, and the loss of GPS synchronization was considered a critical fault that prevented normal telescope operation. Overall, the architecture relied on distributed subsystem coordination, with the Control PC acting as the central node for telescope control, tracking corrections, and communications.

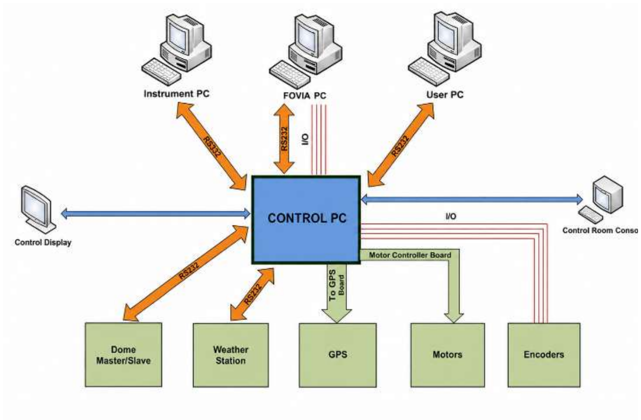

Fig 2. Old IAC80 Control System

III. Overview of the New Control System

Figure 3 shows a schematic representation of the network topology selected for the IAC80. The architecture includes the following Programmable Logic Controllers (PLCs):

Telescope PLC. This PLC controls the telescope axes, the dome, the focus system, the petals, and the EtherCAT node referred to as the Installation Node. The Installation Node manages the emergency stop buttons, the inclinometer, the dew sensor, monitors the electrical power supply status, and enables manual telescope control. The Telescope PLC also communicates with the FOVIA system to read the guiding error and establish operational protocols. In addition, it communicates with the Window–Shutter PLC through the WiFi router.

Window–Shutter PLC. This PLC controls the dome window and shutter mechanisms. It communicates with the user interface, the Telescope PLC, and the Installation Node.

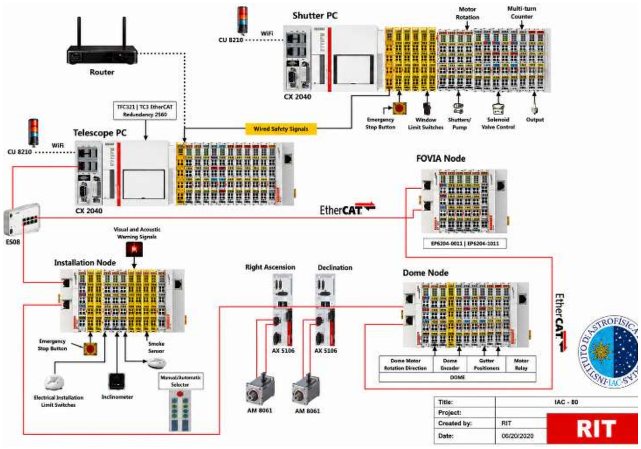

Fig 3 IAC80 EtherCAT Network Architecture

The incorporation of new 24-bit encoders, replacing the previous 18-bit units, made it possible to significantly improve the telescope pointing resolution and accuracy. This also led to the proposal of replacing the FOVIA guiding camera with a commercial camera based on the GigE Vision protocol.

Fig 4 shows the architecture of this new guiding system integrated into the Telescope PLC.

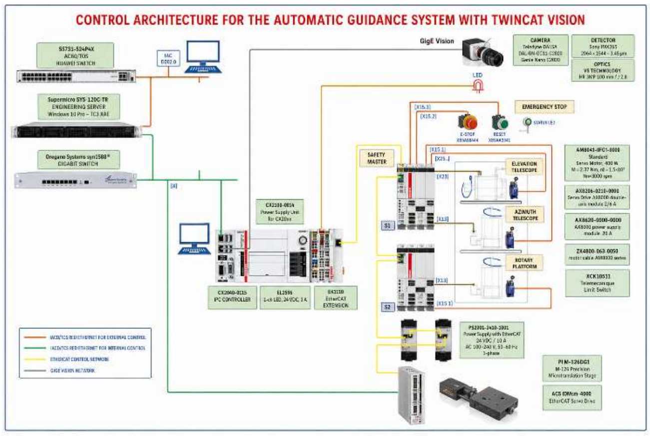

Fig 4. Control Architecture for the Automatic Guidance System

Figure 5 shows the proposed synchronization architecture. The capability of the EtherCAT bus to provide a stable synchronization network has been widely validated in other projects.

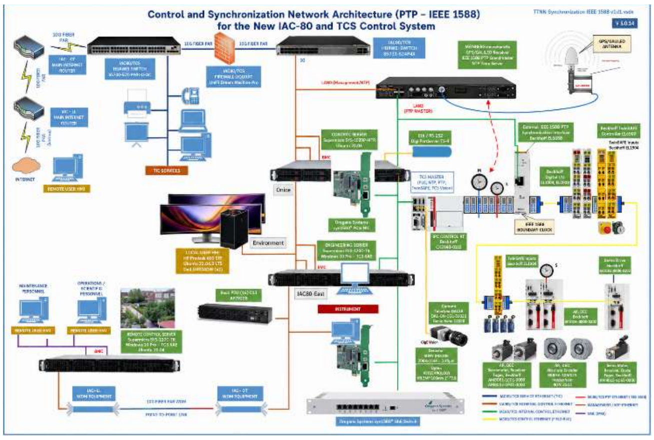

Fig 5. Control and Synchronization Network Architecture (PTP – IEEE 1588)

IV. Current Status of the Project

Figure 6 shows the integration of the new Beckhoff servo motors into the right ascension axis gearbox. Their higher power and direct coupling to the transmission gearbox eliminated mechanical vibrations and reduced noise. Higher slewing speeds and improved positioning resolution were achieved thanks to the new encoders. The focus control system is currently being implemented, while the dome control system is planned for the near future.

Fig 6. The new Right Ascension motor drives the gear box directly.