Bull. Astr. Soc. India (1999) **27**, 319-321

# Computer network-based data acquisition and control system for the imaging element of the TACTIC array

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**Abstract.** An interrupt-driven distributed Data AcQuisition and Control System (DAQCS) has been developed for the Imaging Element of the 4-element $\gamma$-ray telescope array, TACTIC. A network of PCs, running the QNX RTOS, have been coupled to the front-end CAMAC-based instrumentation modules. Single-point monitoring and control from a designated node with an elaborate GUI has greatly facilitated the operation of the telescope and its sophisticated, multi-pixel imaging camera.

## 1. Introduction

When fully operational, the Imaging Element (IE) of the TACTIC array will deploy a 349-pixel Cerenkov Light Imaging Camera (CLIC) for observing celestical $\gamma$-ray sources. With the 81 pixels presently commissioned, the IE has successfully detected several episodes of intense flaring activity from the BL-Lac object Markarian 501 (Mkn 501) during April-May, 1997. The large number of input data channels, coupled with a projected event rate of ~ 30 Hz, has necessitated the use of distributed multiprocessor-based data acquisition and control system for the TACTIC. 486-based PCs, interconnected over ethernet, have been used as individual nodes of the system. To ensure low interrupt latency and to implement concurrent multiple process operation, a multitasking RTOS platform QNX has been used. The high level of inter-process communication (IPC) facilities available with this RTOS, have been used to advantage in the design of the system.

## 2. System organization

Fig. 1 gives a block-diagram representation of the DAQCS successfully designed for the IE. The 3-node system has specific processes running on each individual node. The photomultiplier-pixel gain-control is implemented by controlling the HV to each pixel through the HT device driver on node #3. As this process is not time critical, it services each of the 349 channels in a sequential manner. The channel-gain calculations are based on library data of its single-channel rate (SCR) as a function of the EHT for different levels of incident light flux (Rannot et al., 1995). Whenever the SCR of any channel strays beyond the preset range ~ $(10 \pm 5)kHz$,

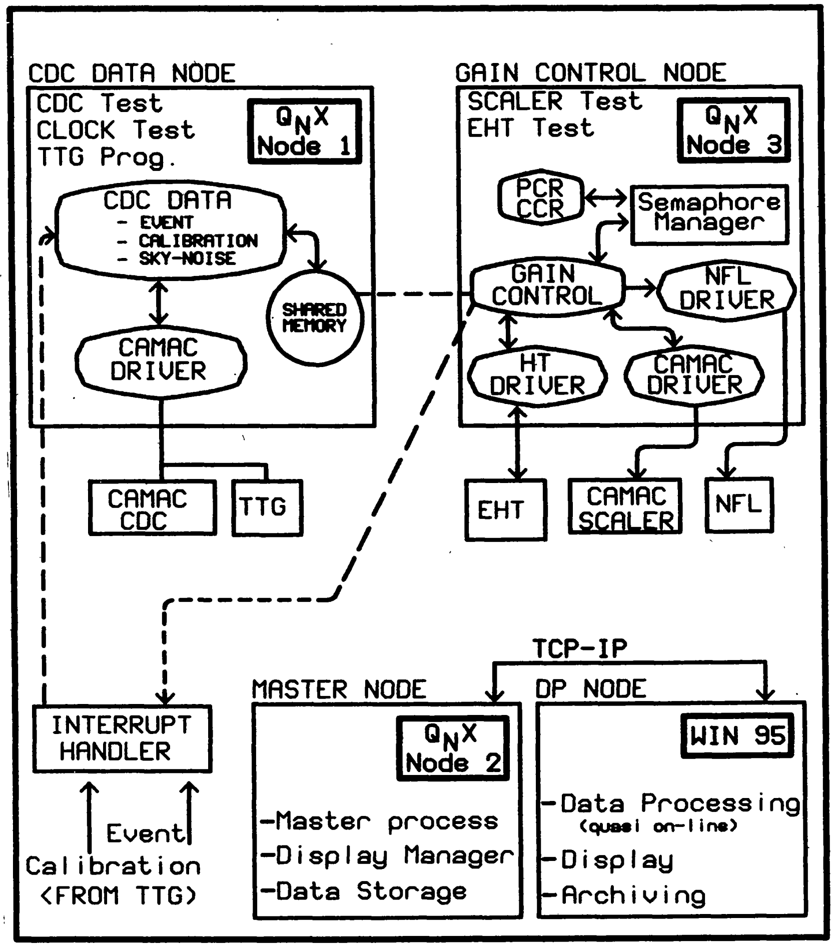


**Figure 1.** The block-diagram of the multinode PC-based DAQCS of the TACTIC IE.

in response to a significant variation in the incident light flux, the EHT of the channel is changed suitably as per the trend provided by the above-referred library data. Node #3 also monitors the prompt and chance coincidence rates (PCR & CCR) concurrently. A Semaphore Manager utility has been written for handling operations of the loop gain-control and rate monitoring processes. An interrupt-driven data acquisition process is active on the node #1. At the occurrence of an event, which is signalled by the TACTIC Trigger Generator (TTG) module (Bhat et al., 1994), the charge content of all the camera pixels is dumped onto the hard disk. Two interrupt levels have been used for handling, on one hand, the PCR and, on the other, the calibration data of the camera. The pixel-calibration runs, followed by composite-noise monitoring runs are taken whenever the gain (≡ EHT) of any CLIC pixel has been changed to restore the SCR to its preset level. This interrupt level switching is implemented in hardware by the Interrupt Handler circuit under the control of the loop gain-control process running on node #3. With 12 concurrent processes running across the network, the data acquisition system is capable of handling input event rates of upto 200 Hz for the 81-pixel camera. Hardware control of the Nitrogen Flash Lamp (NFL), used for the relative gain calibration of the pixels, is also implemented under the control of this process. Both the nodes also run elaborate off-line test programs for debugging. A globally-accessible, shared memory block on node #1 is used for synchronisation of the clock information across the network.

Node #2, designated as the master node, is connected to the two control nodes via 10MBPS ethernet. The hard disk of the master node is used for storage of data and the individual process-executable files. The initialisation process spawns the node-specific processes to their respective nodes for operation and displays the monitoring information received from these processes. The master node has also been provided with TCP-IP connectivity to a Windows '95 node which is used for quasi on-line data processing and archiving on DAT tapes. The DAQCS software is provided with all the necessary safeguards to ensure a trouble-free operation of the telescope hardware and to closely monitor designated operations of all its sub-systems.

## 3. System performance

The DAQCS has been operating satisfactorily for about a year now. The SCR stabilisation algorithms in use have a fairly quick response, which ensures that the stabilisation of all the 81-pixels of the CLIC takes place within a few minutes after switching on the system. With the present 81-pixel camera, about 10MB of event- and house-keeping data are typically logged during an observation period of 1 hour. This value is expected to increase to about 300MB/hr when all the 349-pixels of the IE are commissioned by the end of 1998.

## References

Bhat C. L. et al., 1994, NIM, A340, 413.

Rannot R. C. et al., 1995, Proc. 24th ICRC, 3, 738.