Figure 2: *The fork arms on the reference plane. The seats (holes) for the drive units and for the big ball-bearing of the elevation axis are clearly visible.*

at each end of the altitude axis, each driven by two servodrives via two pinions. The azimuth drive system consists of a stationary toothed wheel on which four pinions, one for each servodrive, are engaged.

The absolute position of the telescope is measured by two directly coupled absolute encoders. The tracking is controlled by two friction-driven incremental encoders. Each axis is provided with one absolute and one incremental encoder.

An important aspect in the design is the maximum exposure of the telescope to the external environment during observation. This approach has been selected in order to provide maximum ventilation to the structure, thus allowing for thermal stabilization of the telescope to night conditions and avoiding the trapping of layers of air at different temperatures in the path of the optical beam, which would cause blurring of the image. The building floor is actively cooled, as are all heat sources located on the telescope.

The mobile part of the building is octagonal, has three storeys and rotates on a cylindrical concrete base.

The instrument rooms are on both sides of the telescope behind the side walls of the telescope room. The control equipment occupies a separate lower floor. At this level is also a room for the technical services of the building.

In order to keep high pointing and tracking accuracies with good ventilation at the same time, the telescope is protected at the front and back by permeable wind-screens which control the wind speed in the chamber where the Telescope tube sits.

The temperature in the telescope room and in the instrument rooms is maintained at the level of the outside temperature at night, achieved by means of an appropriate thermal insulation and air conditioning system.

NTT Control/Acquisition Software

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In these months, while the main mechanical and optical components are being prepared for the NTT, the control software has also to meet its first deadlines. In a few months, members of the Electronics Group will be testing the main telescope movements at INNSE in Brescia.

This will be the first result of a preparatory work, which started a couple of years ago. The present description should highlight new aspects of the NTT software with respect to the control/acquisition systems presently in use at La Silla.

The NTT control system design in general (electronics and software) was designed by the TP Electronics Group. People who are specifically working at the NTT software (some part-time or for a limited period of time due to other ongoing projects) are P. Biereichel, B. Gilli, B. Gustafsson, J. Marchand, G. Raffi, K. Wirenstrand from the Electronics Group and L. Noethe from the NTT Group.

In this issue of the *Messenger* the general structure of the NTT control/acquisition system is summarized. In future issues some areas will be expanded more in detail, like: user interface; pool: parameter data base; microprocessor software, and acctive optics software.

Computers

Figure 1 shows the NTT control computer configuration. As the control electronics of the NTT was designed to be distributed, in order to reduce cabling and therefore increase reliability, a number of crates (based on the VME standard) are used for the telescope control functions. The VME crates incorporate microprocessors of the Motorola 68000 family and are all linked via a Local Area Network (LAN) of the Ethernet type.

The control computer of the NTT is a Hewlett Packard A900, which has the function of coordinating the distributed control system, perform data acquisition, accommodate user interface and image processing and support remote control. The A900 minicomputer is the newest member of the HP1000 family based on newer and more compact technology and with computational performances a factor of two better than HP1000 F computers.

Software

Software control and data acquisition systems serve the purpose of managing telescope, instrument, detector, image processing operation in a way which has to be comprehensive and clear for the user. The need for a data acquisition system has been recognized and implemented at La Silla already some years ago. The NTT, however, is the first case where a comprehensive system design has been done right from the beginning.

The main requirements of the NTT system were to accommodate distributed control electronics and two instruments which will be permanently connected. This in turn led to specify that the software should allow multi-instrument operation and multi-user operation (or multi-station) as a consequence of the simultaneous use of more than one instrument and of remote control.

Additional needs, which had a large impact on the design, were remote control and user interface. Finally, during the whole design phase of the NTT system, much attention was payed to see that the present design work could also be used for the VLT and thus represent a first test bench for this instrument.

Altogether the NTT control/acquisition system can be characterized in the following way:

– *Distributed system:* Programmes can be either on the A900 or on any

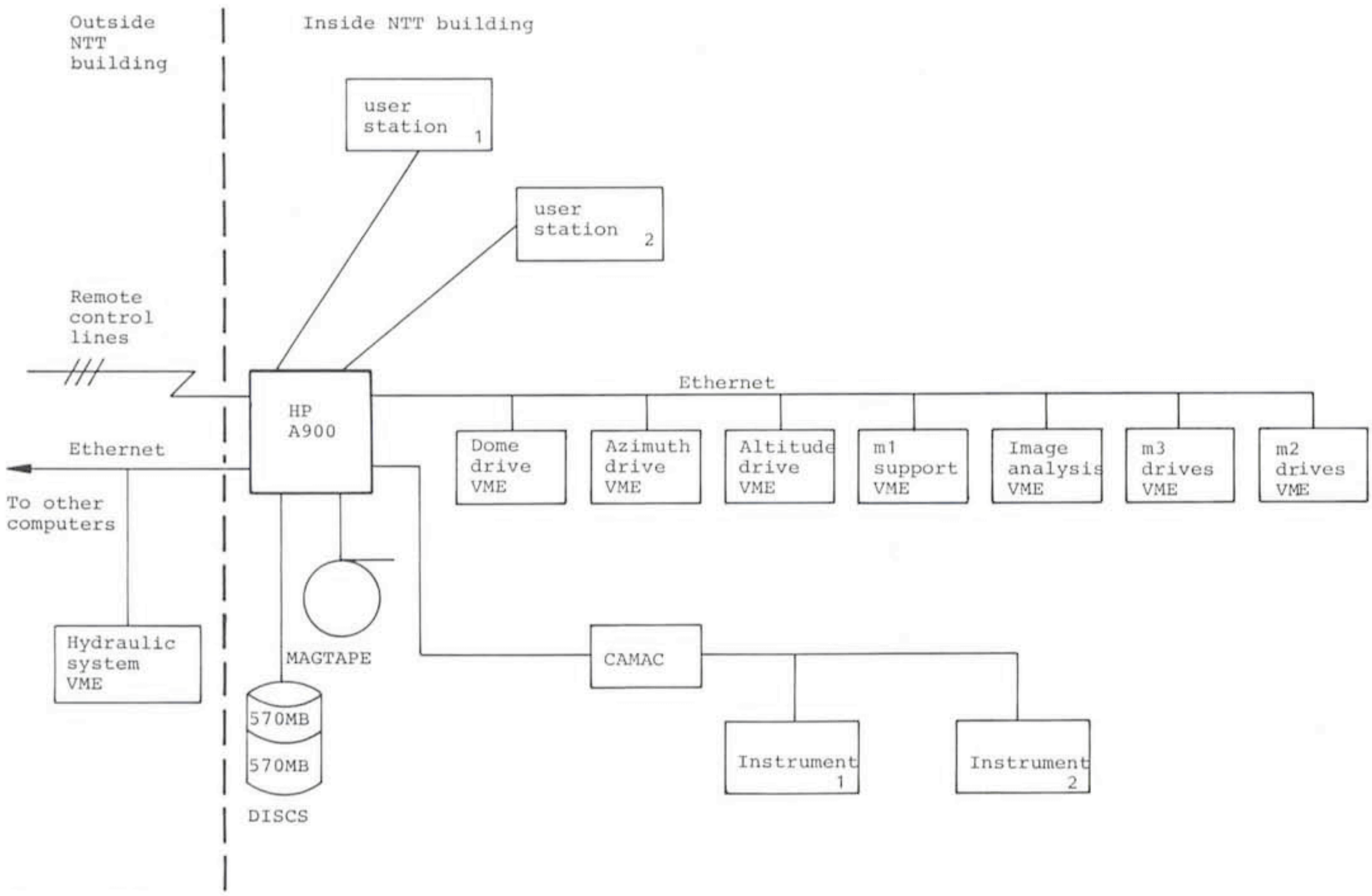

Figure 1: *NTT control computer configuration.*

microprocessor connected to Ethernet. Rules and protocols had to be designed so that commands/replies and data could be exchanged transparently, i.e. without differences due to where the programme is running. So one can visualize the NTT software as distributed on many CPU's, while up to now microprocessors were always used as "black boxes", with a special protocol with every one of them. A very relevant activity in this area was to define and implement a suitable real-time system for the microprocessors and adequate cross-support tools. Then interfacing both with Ethernet and with the control electronics hat to be coped with, namely the writing of corresponding drivers, which is still an on-going activity.

– *Multi user/instruments system:* Many operational environments can run at the same time (not only one as at present), though clearly certain parts like the control of the light beam will belong to one instrument only at one given time. Booking of devices enforces protections and interlocks and separates users. Image processing can be done with IHAP on many independent data bases. Multidetector operation, like in the case of EMMI, is also implicitly included into in this concept.

– The system can accommodate several user stations, where users will be doing simultaneously different activities. Stations are identical in hardware and software. In practice different users will choose different tables and menus in accordance with the work they are doing, namely: active use, monitoring, off-line work.

– *User interface:* This had to be updated not only because of the inadequacy of the present terminals, but mainly for the need to have a more flexible and easy to modify user end. To improve the physical user end, the display information was brought to a large colour monitor (with softkey, tables, graphics, etc. . . .) of the Ramtek type (with the advantage that this is interchangeable also for image processing use). To improve the operational aspects, the user sees now a unique set of commands for different purposes (telescope control, instruments, detectors, image processing), rather than a set of terminals. The layout of the user end can be easily modified, as this layer of software does not belong to any specific control package and basically sends commands to any control programme, receives and displays replies.

– *Pool:* To enforce complete independence of control modules for multi-instrument operation and to detach the user end from the rest, it was not enough to define interface rules and protocols. A lot of information has to be exchanged between various modules (e.g. between instrument and telescope) and a large number of parameters needs changing/updating as soon as new modules are added. It has in fact to be remembered that a control/aquisition system has to be open to allow additions. For this purpose a data base, named Pool, has been implemented, where the time critical files are kept in memory. Tools will be available to read and display what it contains, easily monitoring an operation going on in the system (e.g. monitoring from a remote site control operations).

– *Remote control:* For a description of the last tests on R.C. see the article in the *Messenger* No. 44, June 1986. R.C. concepts have been embodied in the design of the NTT control/acquisition system and it will benefit from the features described before. One relevant example of the impact of R.C. on the design is the Pool, where local files are residing on one computer while global files are kept updated on two computers (local and remote). Meanwhile R.C. will be operational on the 2.2-m and on the CAT telescopes starting with July 1987, so that more experience might be acquired before installing it on the NTT.

So far all the basic elements of the system have been implemented, while work is still proceeding on the specific control programmes for the different telescope components.