

NOT NEWS

No. 2 *** July 1990

Nordic Optical Telescope Scientific Association

First allocation period.....

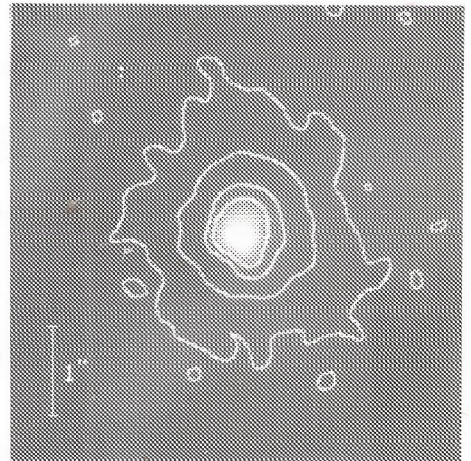
Getting the telescope and its instrumentation ready for the first period of scheduled science programmes was not entirely trivial. However, it was highly rewarding. With a slim offer of auxiliary instruments, we still received a high number of applications for observing time. A total over-subscription rate close to five made us feel next to useful. Feeling the pressure, we slightly enlarged the time available for science programmes. Whilst this undoubtedly gave some extra instant happiness, the wisdom of the corresponding decrease of technical time might naturally be discussed. Still, our definite impression is that we have learnt a lot from our first regular observers, and not necessarily so only from those showing total satisfaction.

In total, we managed to schedule 25 observing periods from the middle of April until the beginning of October. In 17 of these programmes, the CCD camera was employed and in 7 the photopolarimeter. In two programmes, the IR spectrometer was used. This instrument was requested by several groups, but due to its early stage of commissioning, it could be used only under special arrangement. For one programme, non-standard instrumentation was involved.

..... and the second one

Still heavily involved with technical work on the Nordic Optical Telescope, we dare issue a Call for Proposals for observing time during the second allocation period. This period covers the time from around the middle of October 1990 to the end of March 1991. At the time of writing, we feel confident enough concerning the telescope to raise the time for science programmes to 75 per cent of the total time available. We recall, that of the observing time available for science programmes, 20 per cent is due to our Spanish colleagues, whilst 5 per cent is due to international programmes allocated by the Comité Científico Internacional (CCI).

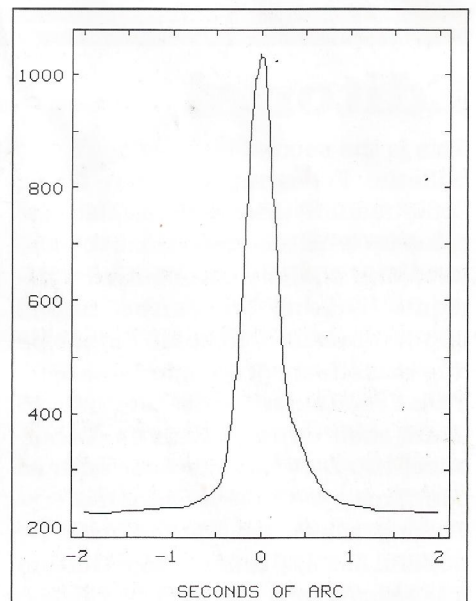
It is presumed that the CCD camera and the photopolarimeter can be used during the second allocation period as during the first. We hope that the same will hold for the IR spectrometer. A decision should be taken after the observing period in July. Astronomers interested in using the IR spectrometer should apply for time. We believe that chances are rather favourable. Depending on the state of the high-speed photometer, programmes requiring data at higher frequency will, in case of allocation, be scheduled either on this instrument or on the



Short exposure obtained on March 12, 1990, giving an image quality corresponding to FWHM = 0.35 arc seconds.

Squeezing image sizes

See page 2



Cut through CCD image.

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photopolarimeter. Finally, there is good hope that also the low-resolution spectrograph can be used for scheduled science programmes.

In summary, we daringly offer the Nordic Optical Telescope for use during the second allocation period, October 1990 through March 1991, to be used together with our CCD camera and photopolarimeter, probably also with the IR spectrometer, for high-frequency photometry either with the high-speed photometer or

the photopolarimeter in high-frequency mode, and, hopefully, with the low-resolution spectrograph. The CCD camera, the photopolarimeter, the IR spectrometer and the high-speed photometer were described in the first issue of NOT NEWS. A description of the low-resolution spectrograph can be found in the present issue. Applications are most welcome. Our formal Call for Proposals is distributed jointly with or in advance of this issue of NOT NEWS.

High Image Quality

Arne Ardeberg, Hans Kjeldsen, Peter Linde

In our first issue, we noted that, at that time, no systematic study of image quality had been attempted. With our small staff and long list of things to do, this statement is still valid. At the same time, the first half of 1990 has confirmed earlier impressions that our resulting image quality is rather favourable. In addition, experience has proven, that high image quality is not something limited to the summer season only. On the contrary, quite excellent seeing conditions have prevailed during a considerable part of the observing nights.

Beating the record

With final alignment still pending, as well as installation of the new control system, it seems somewhat prema-

ture to enter into a detailed quantitative discussion of image quality. However, it seems appropriate to state that FWHM values below 0.8 arc seconds are rather abundant. Especially regarding the optomechanical quality of the telescope and the control of man-made turbulence, it seems interesting to note that we have defined a new record for image quality. A number of short exposures have delivered FWHM values below the old limiting value, 0.45 arc seconds, given in NOT NEWS No.1. The best of these exposures gives FWHM = 0.35 arc seconds, being our new record. It is emphasized that the data reported are based on measurements of raw CCD images with no attempt at image processing. See also figures on page 1.

Editorial

This is the second issue of our news bulletin. Following the first issue, some readers (friends and relatives) came up with reactions close to positive. The scarcity of negative comments (passing our narrow filters) might, of course, to some extent be due to modesty of our angry readers. These readers are most welcome to share their outrage with us. Otherwise, you may have to bear with us continuing in the style adopted.

Writing a news bulletin dotted by hopeful hiccups is one thing. Getting a telescope into safe and rewarding operation is something slightly

different. Even the realization of this banal truth does not carry us a long way towards those distant goals correctly visualized by hopeful observers. We think (hope?) that we are not too far away from a reasonable track. Great ideas are invaluable, hard work is unavoidable. Both have characterized the work of the construction staff as well as the staff now operating the telescope at Cruz del Fraile. Both groups have been and remain small in number but high in professionalism and spirits. All of us invite all of you to go on pushing and kicking for further achievements.

The Nordic Optical Telescope (NOT) Scientific Association was founded in 1984 to construct and operate a Nordic telescope for observations at optical and infrared wavelengths. Associates are Statens naturvidenskabelige forskningsråd, Denmark, Suomen Akatemia, Finland, Norges almenvitenskaplige forskningsråd, Norway, and Naturvetenskapliga forskningsrådet, Sweden. Executive bodies are the Council and the Directorate. Advice and assistance is provided by a Scientific-Technical Committee.

The Nordic Optical Telescope is a 2.56 m telescope with altazimuth mounting and Cassegrain focus. The primary mirror has a focal ratio of $f/2.0$, the combined optical system a corresponding focal ratio of $f/11.0$. The telescope is installed at Cruz del Fraile, Observatorio del Roque de los Muchachos, La Palma, Islas Canarias. Geographical longitude is $17^{\circ} 52' 59.7''$ West, geographical latitude $28^{\circ} 45' 20.5''$ North, and altitude 2382 metres above sea level.

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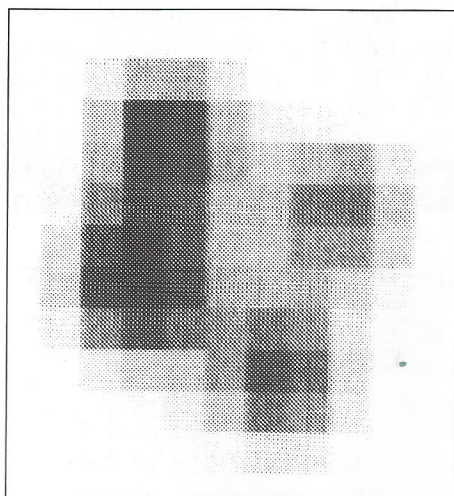
Observing with the NOT

Per Olof Lindblad

On April 20 - 24 of this year Maja Hjelm from the Stockholm Observatory and myself had the pleasure to be the first Nordic regular observers with the NOT. Our programme was to observe nuclei of nearby active galaxies through suitably redshifted narrow band filters selecting the [OIII] 5007 and H α emission lines. The aim was to search for jets and structures that might be different in the light of the [OIII] and H α emission. In case of very good seeing we also wanted to observe the quadruple quasar gravitational lense H1413 + 117 in order to test the feasibility of such observations with the NOT. Our introducer to the telescope was Hans Kjeldsen.

The first observing night the seeing was very good, so we set out to take our test exposure of H1413 + 117. The figure shows our only frame of this 17th magnitude quadruple quasar exposed for 15 minutes through a standard R filter. The smallest separation between the components is 0."77 and they are well resolved. From a star in the field the seeing was estimated at 0."7. Also, this frame shows that autoguiding worked well during these 15 minutes. Depending on the redshift and mass of the hypothetical lensing galaxy, the time delay between intensity variations of the different components of the quasar image is estimated to be between two weeks and a year. As the Stockholm CCD is a stand by instrument, it could be feasible to plan a special collaborative program to detect such time delays.

Our first priority in our list of active galaxies was NGC 4258. Its nucleus contains a prominent bisymmetric H α jet discovered some 30 years ago by the Marseille group. The unique feature of this spiral galaxy is the large, curved radio continuum plume, which was one of the early surprising discoveries with the Westerbork telescope. Already at the telescope it was evident that our narrow band [OIII] frame showed a curved [OIII]



15 min R exposure of the quadruple quasar H 1413 + 117. Smallest separation between components is 0."77. North is left and East is up.

jet or structure of a few arcseconds size. Unfortunately, our following three nights we were sitting in the midst of dense clouds, so we obtained no H α picture of this structure.

To observe with NOT was a very positive experience. We were impressed by the ease to operate the telescope, not the least because of the accurate pointing and good autoguiding. It was very pleasant to experience the very positive and help-

ful attitude of all the staff and the knowledge and keen interest shown by our introducer.

Some difficulties we met and to which cure should be sought should be mentioned. For narrow band imaging of a sample of redshifted galaxies, six filters in a wheel is a small number. Without a larger filter slide, planning of observations and compilation of filter sets is a delicate task. Also, plan your observations as if every observing night, even the first one, is the last.

When taking flat fields against a bright sky or the inside of the dome there is a large amount of scattered light within the dome. Depending on the equipment in the Cassegrain focus, there can be a large amount of scattered light also in the adapter that will reach the detector without passing the filter. This can amount to a very considerable fraction of the light passing through the narrow band filter.

Finally, we would urge observers to invent accurate methods to premeasure guide star coordinates from the Palomar atlas. This can save much valuable observing time.

New Gadgets

Those fantastic technicians and astronomers. Against all reasonable odds and frightening experience, they never give up. Thus, work is still going on to finish further instruments for the Nordic Optical Telescope. In Lund, very final testing of the uvbyHB photometer is going on under Swedish skies as appropriately clear as ever. At the same institute, work is continuing on the long-slit, medium-resolution Boller and Chivens spectrograph. In collaboration with Finnish colleagues, Russian astronomers

and technicians are making advanced progress on the spectrograph designed for work at high resolutions. Also, the ESA Photon Counting System, now at the Roque de los Muchachos, may soon be opened for use by visiting astronomers. Finally, the VELUX spectrograph should, in the near future, enter its definition phase, in which also facilities for radial-velocity work will be discussed. More optimistic notes on new instrumentation may hit you in coming issues.

Eclipse of oscillations reveal structure in the accretion flow onto a magnetic white dwarf

Stefan Larsson, Vilppu Piirola, Leo Takalo

AM Her type cataclysmic variables are close binary systems with accretion onto a highly magnetic white dwarf. A few of these systems are known to show quasi-periodic oscillations (QPOs) on time scales of 1-3 seconds. Although the oscillations have been localized to the column of shocked plasma above the polar cap, it is still not clear by what mechanism they are produced. One of the QPO sources, VV Puppis, is of particular interest since in this case the rotation of the white dwarf gives rise to periodic eclipses of the oscillating region.

Observations with the high speed photometer at NOT in February 1990 have been used to study the properties of these QPOs, in particular at eclipse ingress and egress. There was an indication from our previous observations at ESO that the low frequency range of QPOs dominated at these phases. The new NOT observations seem to have established the reality of this effect, which is shown by the power spectra in the accompanying figure.

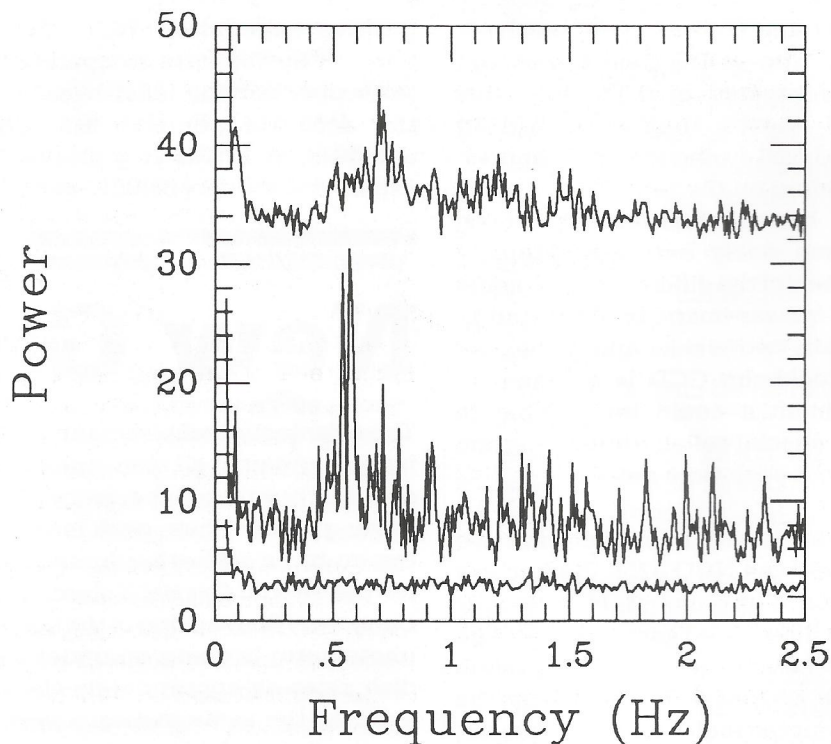
The flat power spectrum at the bottom of the figure, which does not show any QPOs, was calculated from the faint phase data, i.e. the part of the rotation period when the accreting pole is on the back side of the white dwarf. During the bright phase, when the polar region is on the facing hemisphere, the oscillations appear as a broad "bump" of power excess between 0.5 and 1.0 Hz. This is shown by the power spectrum at the top of the figure. The additional power excess around 1.2 and 1.5 Hz is probably the first harmonic of the main

QPO peak, although this has not been seen in earlier observations. The power spectrum in the middle of the figure finally, was calculated from data covering just a few percent of the rotational period around eclipse ingress.

The fact that the low frequency oscillations are the last ones to be eclipsed, and also are the first ones to appear after the eclipse, suggests that they occur in a region that is more extended (either in height or width) than the region exhibiting the higher frequency oscillations. Such a

difference in height is actually predicted by the presently most favoured model for the QPOs.

In that model, the QPOs are associated with oscillations in the height of the shock front above the stellar surface. Both the shock height and the oscillation period depend on the cooling efficiency for the shocked plasma. In this model it is therefore possible to relate the QPO properties to physical parameters in the plasma, and also to use the eclipses to probe the structure of the accretion column as indicated by our observations.



Power spectra for the AM Her system VV Puppis calculated from data covering the bright phase (top), eclipse ingress (middle) and the faint, eclipse phase (bottom) of the white dwarf rotation period. The observations were made with the high speed photometer at NOT in February 1990.



Part of the NOT control system. NOT resident astronomers Leo Takalo and Lars Olof Lodén observe a highly interesting stellar cluster. Photo: Per Lindström.

The NOT Computer Control System

Niklas Holsti

The NOT 2.5 m telescope was designed to be computer controlled. The computers make the telescope track an object, adjust the focus, shift the secondary to compensate for tube bending, and control the adapter optics and electronics. The dome shutters and mirror cover are also opened and closed through the computer. This keeps the observer away from the cold area around the telescope and permits remote observing. The control system allows more than one simultaneous user. Typically, there is one local user, the observer or telescope operator. Separate instrument-control computers can be connected as other "users". When telecommunications to La Palma improve, observers will be able to control the telescope from terminals in the Nordic countries.

The control system consists of several tens of cooperating programs, running on six interconnected computers. The observer interacts with only one of these, however. The observer

terminal in the control room is an ordinary alphanumeric terminal with a keyboard and a screen. The status information on the screen (date, time, coordinates, and so on) is updated every second. The function keys (PF1-PF4) and numeric-keypad keys (0-9,+) are connected to a set of menus. The menus contain the common commands, grouped by function, for example ADAPTER menu or GUIDE-PROBE menu. Most commands can also be typed in. The program has a flexible prompting and helping system. It will be possible to execute prewritten command files.

The cursor control keys move the telescope. When the telescope is tracking, the up-down cursor keys control declination and the left-right keys control right ascension. When the telescope is not tracking, the keys control elevation and azimuth.

Next to the observer terminal is a monochrome monitor for the guiding TV, which is based on an intensified CCD

with limiting magnitude about 17. A colour monitor for the autoguider display is mounted on the wall above. The control terminal and image monitor for the cooled CCD camera are also close to the observer terminal. The guiding TV is used to find objects, to track guide stars, and to view the instrument aperture by means of a periscope mirror in the instrument adapter.

Usually, each instrument attached to the telescope is controlled by its own PC. An interface and protocol has been defined for the transmission of date, time, coordinates, and other "header" data from the telescope computers to the instrument computers. The current instruments do not yet use this, however.

Typical Observation

When all the functions of the software have been implemented, a typical night at the telescope will go as follows. A command to start up the telescope is first selected from a menu. Next, other menu commands open the dome hatches and the mirror cover. The coordinates for the first object are then typed in. Alternatively, the object can be selected from a catalogue displayed on the screen. The catalogue can be typed in during the day, or read from a PC-format diskette. Coordinates can be given in any epoch. Proper motion can be specified.

Next, the desired field rotation angle is set by a command to the rotator unit, and the guide probe is moved into the center of the field. When the object appears on the guiding TV monitor, telescope offsets are applied for the chosen instrument. (Faint objects can be found with the cooled CCD camera, which is always mounted.) The guide probe is then parked away from the beam, or moved to a guide star for autoguiding. It is advantageous if the coordinates of a guide star are known beforehand, since scanning the field to find a guide star may take some time. The guide star coordinates can be given in any epoch, or from a catalogue.

Once the guide star is visible on the monitor, it is selected by pointing with a mouse, and a menu command

starts the autoguider. When the observation is complete, the auto-guider is stopped, and the next object observed. The system monitors the weather, and the observer is warned if wind speed or humidity are too high.

At the time of writing, we have not yet implemented computer controlled power-on and power-off, nor entry of catalogues from diskettes. As yet, there is no provision for solar-system objects - in this case, the observer should bring apparent equatorial coordinates for the times in question. Guide stars should, preferentially, be at least 12th magnitude, because the autoguider does not integrate TV frames. The faint end of the FK5 catalogue, about 2200 stars, is on-line and can be used for pointing checks or other calibrations.

Implementation

The main programming language is Pascal. The programs were initially designed and implemented by Ingvar Svårdh (Risø Nordic Telescope Group) and have been developed further by Niklas Holsti with assistance from Leo Takalo.

The autoguider is a commercial frame-grabber/image-processor board (ScanBeam 1024) containing an MC68020 processor and running in a VME crate. It receives the video image from the guiding TV, and computes an offset by comparing the total intensity in four quadrants of a square aperture placed on the guide star.

The computer hardware is now being updated. The old system consisted of a Norsk Data ND-100 16-bit minicomputer as the main computer, and four so-called "subunits", each a Motorola MC68000 processor running VERSAdos in a VME crate. The computers communicated over an IEEE-488 (HP-IB) bus. The computers were ageing, were not really fast enough, and maintenance of the ND-100 was uncertain. Noise on the IEEE-488 bus was a problem sometimes.

New computers will be installed around August 1990, and will consist of three Motorola 68030 processors in one VME crate. The autoguider will be in the same crate. The opera-

ting system will be OS-9. The IEEE-488 bus will be replaced by optical fibers. The control and servo frequencies will be twice what the old computers could do - a full computation of altitude, azimuth, and rotator angles, including pointing corrections, will be done every 100 milliseconds. The axis servo programs will interpolate these values to 5 millisecond intervals.

Off-line facilities

For off-line work, we have a Hewlett-Packard HP 835/CHX running Unix (HP-UX version 7) and X Windows

(version 11). Pascal, Fortran, and C compilers are available. The colour workstation display has 1280 x 1024 8-bit pixels (256 simultaneous colours) and two overlay planes. We plan to install MIDAS and TEX/LATEX. An HP LaserJet laser printer provides monochrome output. In magnetic tapes, we can only handle 1600 bpi density. A read-write, removable, optical disk unit will be acquired for data archiving. Electronic mail to the HP is planned. It will be implemented, once the communications situation has been improved.

Doctor's column



Torben Andersen and Tapio Korhonen receiving signs of honour. Photo: Jensen, Lund

The key roles of Torben Andersen and Tapio Korhonen in the realization of the Nordic Optical Telescope are too obvious to discuss. Recently, their eminent contributions to Nordic astronomy got officially celebrated. On June 1st, the Lund University had the pleasure of promoting Torben and Tapio to Filosofie Doctor honoris causa. It is noted that to their many records in telescope optics and mechanics, they can now add that of being record young PhD h.c. Celebrating an intensive day with their wives, Torben and Tapio also gave seminars at the Lund Observatory. An overcrowded audience heard them discuss the future of frontier telescope technology. We congratulate Torben and Tapio as well as the NOTSA and the Lund University.



Adequately under-staffed?

When the Nordic Optical Telescope Scientific Association was created in January 1984, this responded to a natural desire of Nordic astronomers to have a powerful telescope to satisfy their observing needs. This can hardly astonish anybody. So much more impressive was the rapid and positive response by Nordic authorities and foundations.

With highest satisfaction we still

remember the ice-breaking offer made by the Nordic Council of Ministers and the accompanying early contributions made by (what we now refer to as) our associates, seconded by private funds and universities. When we, absolutely unexpectedly, had to erect our telescope at a relatively remote site on the Roque de los Muchachos premises, again the Nordic Council of Ministers provided crucial help. For many of us astro-

nomers, it might be a highly sobering thing to reflect on the situation due for these authorities. Not only are they plagued by constant shortage of funds but also flooded by enthusiastic pledges for money.

Naturally, authorities made a good choice when they chose to fund our telescope project. With the telescope delivering frontier image quality, the most prominent shortcoming is that of understaffing. Our highly enthusiastic and hardworking staff members make smashing contributions. Still, there are limits to their availability and capacity. Intrinsicly rather trivial problems may often give large difficulties for visiting observers, simply because nobody is there to take care of them.

The problem of understaffing is fully recognized by Council. One result of this recognition was the creation of an ad hoc committee given the task of studying the staff structure supporting the Nordic Optical Telescope project. Formed at the Council meeting in November 1989, the committee was chaired by Mats Ola Ottosson. Other members were Steven Jörsäter, Poul Erik Nissen, Bjørn Pettersen and Vilppu Pirola.

Based on a careful and detailed study of operation staff at La Palma as well as of supporting technical staff at Risø, the ad hoc committee agreed on a number of statements and advice. The small number of staff is recognized, as is the basic inadequacy of present in-kind arrangements. Organizational changes are recommended, aiming at higher flexibility. As an urgent matter, the committee mentions recruitment of an electronics hardware engineer. The need for continuous assistance from the Nordic Telescope Group is estimated at about 1000 KSEK per year. Finally, the ad hoc committee emphasizes the world-class facility available. The committee concludes, that it would find it a waste, if adequate funding and manpower were not invested to assure its proper utilization by Nordic astronomers.

Hanging on

Do you plan to bring your own auxiliary instrumentation to the NOT? In that case you should make sure that your instrument will fit onto the telescope.

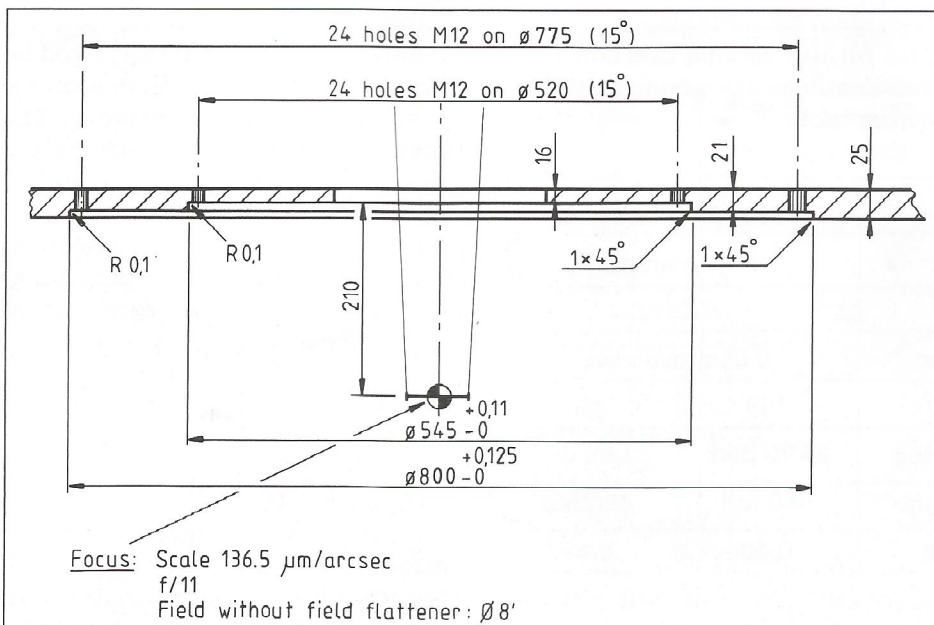
The figure shows a part of the instrument adapter flange, onto which the auxiliary instruments should be fixed. There are two guide surfaces that can be used: An inner surface with a diameter of $\text{Ø}545$ mm and an outer surface with a diameter of $\text{Ø}800$ mm. For normal instruments of reasonable size, we recommend that you use the inner fixation surface.

If your instrument does not fit directly, you may have to bring an intermediate mechanical part that fits onto the

telescope adapter on the upper side and to your instrument on the lower side. It is not permitted to use long bolts with spacer tubes or other distance pieces from the scrap yard. This may cause spurious light to fall onto the standby Stockholm CCD.

Please make sure that your M12 fixation screws are not too long. They should under no circumstances go through the adapter bottom plate since the field viewing camera may collide with the screw ends.

There are two different fork lifts that may be used to mount auxiliary instrumentation onto the telescope. More details on these fork lifts may be obtained from NOT technical staff.



The Aarhus-Tromsø Low-Dispersion Spectrograph

Bjarne Thomsen

Description

Figure 2 is a drawing of the spectrograph optics. The telescope is focused on the aperture plate (we plan to use 3 long slits which are 150 μm , 250 μm , and 400 μm wide) shown at the bottom left of the figure. The aperture plates are mounted in an aperture wheel with 5 circular holes, each 10 mm deep and 82 mm in diameter. The scale at the Cassegrain focus of NOT is 136 $\mu\text{m}/\text{arcsec}$, and the diameter of the field lens 20 mm behind the focal plane is 75 mm, corresponding to an angular diameter of 9 arcmin.

The spectrograph is a two-channel instrument using an aspheric photographic camera lens in the primary channel, and an apochromatic telelens in the secondary channel. The F/11 focal ratio of NOT is transformed into F/2.0 for the primary channel, and F/4.2 for the secondary channel. The image scales are 25 $\mu\text{m}/\text{arcsec}$ and 53 $\mu\text{m}/\text{arcsec}$, respectively. Behind the field lens there is an automatic slide with a 45° mirror, and a 45° dichroic mirror, which makes it possible to switch between the primary channel (empty position) and the secondary channel (mirror position), or to use both channels simultaneously (dichroic mirror). Both channels can use either a front illuminated P8603 (EEV) CCD, or an AR-coated back-illuminated TK512 CCD (Tektronix). The pixel size is 22

μm for P8603 and 27 μm for TK512, respectively. The readout noise is 6.5 e and 9.0 e, respectively.

At present there are 2 grisms mounted in each channel, but there is space for one more grism in each channel. The instrument can also be used as focal reducer. The aperture plates are then replaced by interference filters. It is easy to change from direct mode to spectrographic mode by turning the aperture wheel, and the grism wheels. The aperture plates and the interference filters are much more easily mounted than the grisms.

Calibration

Figure 3 is a drawing of the calibration-adaptor optics. The calibration adapter is located between the low-dispersion spectrograph and the instrumental adapter. During calibration, a lens and a 45° mirror are rotated into position in front of the slit. This lens, combined with the field lens behind the slit, images the exit port of an integrating sphere onto the grism. This image has the same size as the image of the primary mirror of the telescope produced by the field lens alone. Light from a spectral lamp is fed to the integrating sphere by means of an optical fiber.

Technical Specifications

Data for the various detector/grism combinations are given in the following table:

Channel	Primary Channel		Secondary Channel	
Image Scale	25 $\mu\text{m}/\text{arcsec}$		53 $\mu\text{m}/\text{arcsec}$	
CCD	P8603		TK512	
CCD Scale	0.89 arcsec/pix		0.51 arcsec/pix	
Grooves/mm	200	300	420	600
Wedge Angle	15.07 deg.	26.75 deg.	26.75 deg.	33.95 deg.
λ_c	670 nm	770 nm	560 nm	490 nm
nm/pixel	1.21	0.76	0.30	0.19
Spectral range	470 - 1000 nm	560 - 980 nm	480 - 630 nm	440 - 540 nm

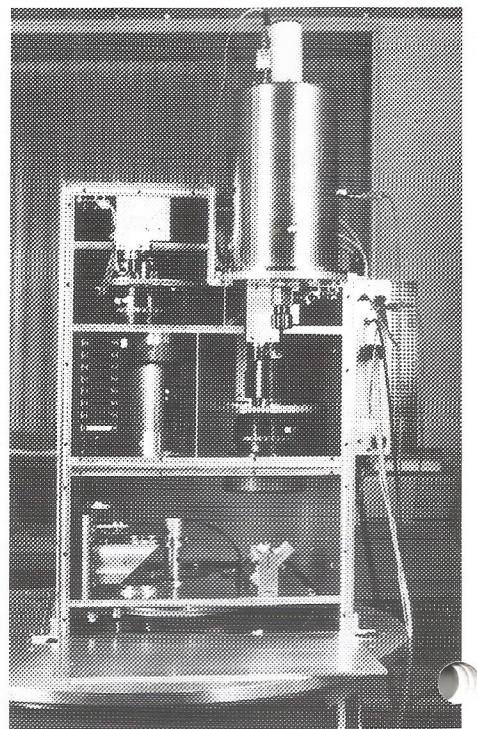


Fig. 1. The Aarhus-Tromsø low-dispersion spectrograph mounted on the calibration unit. An EEV CCD is mounted on the secondary channel. There are in total 7 motors and 2 shutters.

The undeviated central wavelength is given in the row labeled λ_c . The dispersion is given as nm/pixel at λ_c . One resolution element will always contain more than 2 pixels. The primary channel has lowest dispersion, and the two gratings are optimized for the red part of the spectrum. The secondary channel is intended to work in the blue-yellow part of the spectrum, at a somewhat higher dispersion than that of the primary channel. The thinned TK512 will be mounted on this channel, though it is possible to switch detectors. The spectral range of the secondary channel is determined by the detector size. The range in the last row assumes that the slit is centered on the optical axis. It is thus possible to shift the spectral range by decentering the slit.

Efficiency

Figure 4 gives an estimate of the combined efficiency of the telescope, imaging optics, and CCD for the 4 channel/detector combinations. It includes 2 Al reflections (telescope) for the primary channel, and 4 Al reflections (telescope + spectrograph) for

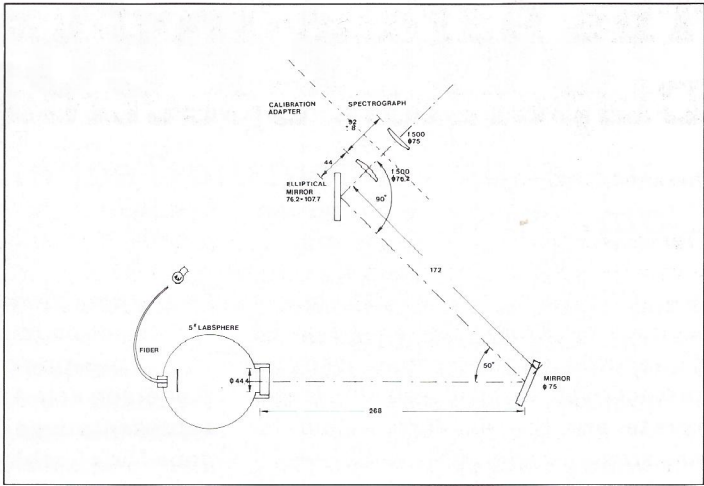
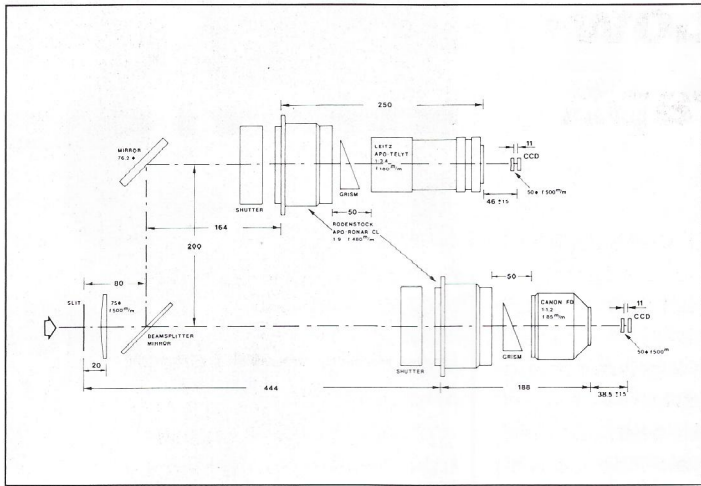


Fig. 2. Optical Layout of low-dispersion spectrograph

Fig. 3. Optical layout of calibration unit for spectrograph

the secondary channel. At present, there are 2 standard dichroic filters from Corion: A red reflective filter separating at 580 nm, and a blue reflective filter separating at 475 nm. The splitting wavelength of the blue reflective filter is too short to be useful with present gratings. For direct photometry, there will be 5 interference filters (v, b, y, and H β) on the Ström-gren system. The efficiency of the secondary channel may be improved in the future by use of custom made dielectric mirrors. We should consider purchase of a new grism optimized for the region around 410 nm.

The 4 curves in Figure 5 represent an (optimistic) estimate of the combined efficiency of the telescope, imaging optics, grism, and CCD as a function of wavelength. It has not been possible to find a commercial apochromatic camera lens for the primary channel. Thus, it is impossible to have the whole spectral range in exact

focus at the same time. This will to some degree degrade the signal to noise ratio at the ends of the spectrum. A quantitative estimate of the importance of this effect must await observations. The camera in the secondary channel is an apochromatic lens, which should give no focusing problems. The curves in Figures 4 and 5 are based on somewhat incomplete data. Nevertheless, they should be sufficiently accurate to give a realistic impression of the capabilities of the spectrograph.

Commissioning

So, when is it ready for general use? This question is very difficult to answer at present. Basically this instrument is a prototype, and we have already made a few modifications to fix problems encountered during testing. The whole project is considerably more complex than the impression you might get by looking at the figures. It contains 7 stepper

motors, 2 shutters, 7 encoders, and 2 different CCD cameras. All this hardware is directly controlled by 2 microprocessors and associated electronics. The microprocessors are supervised by a special control program on a 386 PC. We have also developed a simple image processing system, that can handle and store images from the two cameras. The whole system, mechanics, electronics, and software, has to be assembled and tested, before the spectrograph can be shipped to La Palma for the first test run on the telescope. The thinned Tektronix chip has just been mounted in the dewar for the first time. Preliminary tests are promising, but a full optimization will take several weeks. There is probably still a 50 per cent chance that the instrument is ready for the planned run in September, but this assumes that we do not encounter any new problems in the coming weeks.

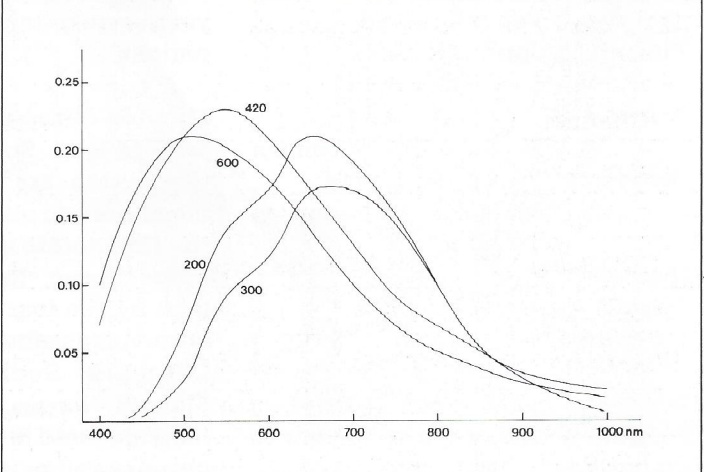
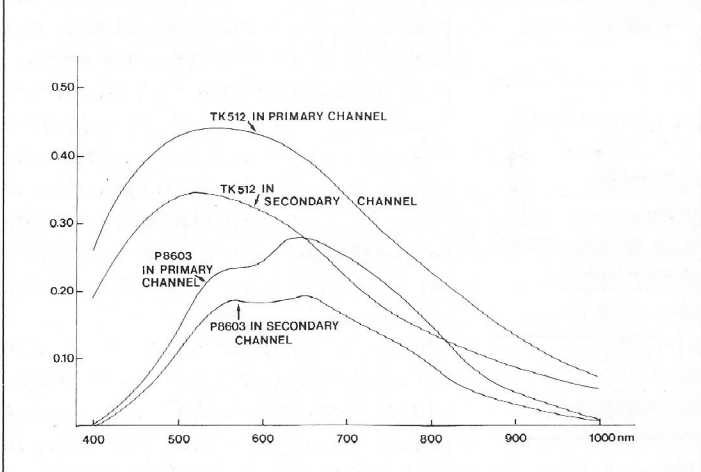


Fig. 4. Calculated efficiency of telescope, optics and CCD

Fig. 5. Calculated efficiency of telescope, optics, grism and CCD

Power People

Council and Scientific-Technical Committee

The Council of the Nordic Optical Telescope Scientific Association represents the governing body of our project. The Council and the Directorate are the executive powers, assisted and advised by a Scientific-Technical Committee. In Council, each of the four associates has two representatives. In addition, the Royal Swedish Academy of Sciences has an observer. Moreover, the Chairperson of the Scientific-Technical Committee is always invited to assist. Always present at Council meetings is the Director, whilst the Head of the Nordic Telescope Group assists occasionally.

The members of the Scientific-Technical Committee are elected by Council for periods up to four years. Council also appoints the Chairperson as well as the Vice Chairperson of this committee. For the time being, the Scientific-Technical Committee has five members. Always present at committee meetings is the Director, the Head of the Nordic Telescope Group often assisting.

By the middle of 1990, the Council of the Nordic Optical Telescope Scientific Association has the following composition:

Members:

- Denmark: Johannes Andersen
Peter Sigmund
- Finland: Jorma Hattula
Mauri Valtonen
- Norway: Kaare Aksnes
Synnøve Irgens-Jensen
- Sweden: Per Olof Lindblad
Mats Ola Ottosson

Observer:

- Royal
Academy: Kai-Inge Hillerud

Chairperson of Council is Per Olof Lindblad, Vice Chairperson Synnøve Irgens-Jensen. Since the end of last year, Birgit Rosengreen has left her duties in our Council for other engage-

ments concerned with international collaboration in science. At the 1990 spring meeting of Council Jens-Ulrik Andersen acted as one of the Danish representatives. We thank Birgit and Jens-Ulrik for their contributions, marked by insight and devotion for fruitful Nordic collaboration.

Also by the middle of 1990, the members of the Scientific-Technical Committee are:

- Steven Jörsäter
- Jes Madsen
- Poul Erik Nissen
- Bjørn Pettersen
- Vilppu Pirola

Chairperson of the Scientific-Technical Committee is Vilppu Pirola, Vice Chairperson Poul Erik Nissen.

Normally, Council meets twice a year. As a rule, meetings take place in late spring and early winter. Urgent matters may imply other arrangements. The Scientific-Technical Committee has, so far, been meeting in accordance with needs, in practice one to three times per year. As one of the most important tasks of the committee is ranking of proposals for observing time with the Nordic Optical Telescope, meetings will, in practice, have to be called at least twice per year, synchronized with allocation periods.

Minutes of the meetings of Council and of the Scientific-Technical Committee are distributed to the members and observers as well as to the Directorate and the Nordic Telescope Group. Reference copies are kept by the four associates, Statens naturvidenskabelige forskningsråd in Denmark, Suomen Akatemia in Finland, Norges almenvitenskaplige forskningsråd in Norway, and Naturvetenskapliga forskningsrådet in Sweden.



Leo Leaves La Palma

Since his arrival, by the beginning 1989, Leo Takalo has spent some considerable time with the Nordic Optical Telescope. His hand with it was famous. Few were the details not fully known to Leo. Whatever the question, whatever the problem, visitors always turned to Leo. And he knew and gave advice, always getting the right data out in the right moment.

By the end of May, Leo returned to Finland, leaving visitors, colleagues and the telescope puzzled and uneasy. Of course, we all know the excellent quality of the NOT operation staff. Still, just in case, it may be good to know, that Leo can be reached through the Turku University Observatory.

Yuppies, our latest assets

By the beginning of this year, two research students joined our staff at the Cruz del Fraile. Hans Kjeldsen comes from Aarhus and Øystein Olsen from Tromsø. Hans bases his thesis work on studies of stellar variability in open clusters. Øystein investigates properties of gravitational lenses. Both are now well acquainted with the telescope and its instrumentation. They take an active and appreciated part in the work at the Cruz del Fraile and will be happy to introduce and assist visiting astronomers.

Nordic Telescope Group at Risø

The Nordic Telescope Group was established in 1984 to design and erect the Nordic Optical Telescope. The bulk of the work on that telescope was terminated in 1988-89. It was decided by NOT to keep the group under such a form that only a minor part of the funding comes from NOT sources. The rest of the activities are project funded, i.e. paid by projects in which Nordic astronomers participate. A project that is very important to the Nordic Telescope Group is the LEST. According to a special cooperation agreement, LEST funds part of the group. Other important activities are related to the ESO VLT project and to the design of auxiliary instrumentation for the NOT.

NOT activities

During the first half of 1990, the group has introduced some improvements and worked on an upgrading of the Nordic Telescope. This work was performed in close collaboration with the operations group on La Palma.

To improve blind tracking, i.e. tracking without autoguider, it was decided to install additional encoders that have high resolution and that are connected to the telescope axes via friction roller drives. Such a system has been designed by the Nordic Group and was installed in April. Due to a transport damage, one wheel must be re-manufactured in Sweden. The system will therefore not be mechanically ready before August.

Also, the necessary interface electronics for the encoders has been designed and manufactured by the Nordic Group. This hardware was installed and tested in May.

Furthermore, the telescope group has assisted the operations group with several minor activities. The weather station has been re-calibrated. Also some start-up circuits (preventing excessive surge currents) have been evaluated and it has been decided to introduce some improvements within the near future.

As mentioned in the last issue of NOT NEWS, it has been decided to

upgrade the computer system of the NOT to a more modern and powerful version. This work is described under a separate heading in this issue of NOT NEWS.

During the period September - December 1990, a number of activities are foreseen in the field of mechanics. The dome hatch drives, which are now electromechanical, will be replaced by an electrohydraulic system with a safety shutdown facility. The filter exchange mechanism of the adapter presently accommodates filters of only 25 mm diameter, and it is complicated for users to insert their own filters. This will be changed. A filter diameter of 50 mm will be used in the future. It will be more easy to insert personal filters. The new system should be ready before the end of the year.

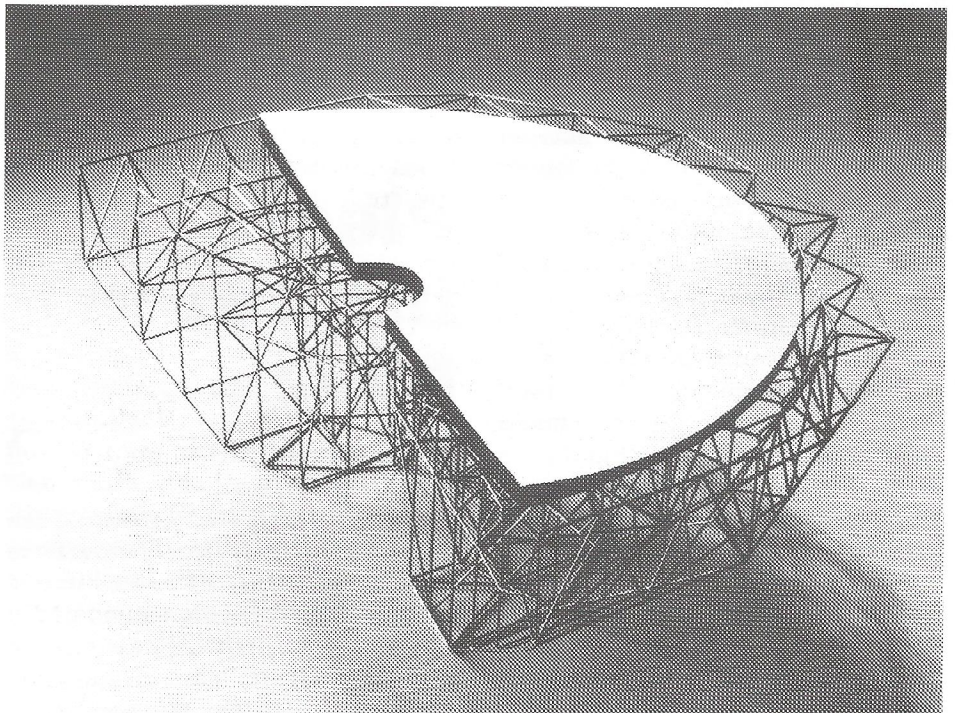
Also, during this autumn, the final optical tests of the optics will be performed. Tapio Korhonen of the Tuorla Optical Laboratory has developed a layout for an optical test device, the so-called Hartmann-Korhonen device. The mechanics of this instrument was designed by the Nordic Telescope Group in Denmark and it was manu-

factured at the workshop of the Institute of Theoretical Astrophysics in Oslo. Presently, the Hartmann-Korhonen device is being tested in Tuorla. During the autumn, the device will be installed on the telescope on La Palma, and the telescope optics will be tested by Tapio Korhonen in collaboration with the operations group and the Nordic Telescope Group.

LEST and ESO collaboration

The conceptual design of the LEST is almost finished and a report defining the design will be published shortly. Following discussions in the LEST community, the design will be frozen during the fall of 1990 and the Nordic Telescope Group will elaborate the documentation for the manufacturing in 1991.

The Nordic Telescope Group has redesigned a mirror suspension unit for the 1.5 m CAT telescope on La Silla. Furthermore, the Nordic Group is presently designing the main mirror cells for the ESO VLT in close cooperation with ESO. The photo shows a model (elaborated by our group) of the truss structure for the main mirror cell. The work includes finite element computer modelling.



The photo shows a model of the truss structure of the VLT main mirror cell. The cell is being designed by the Nordic Telescope Group in collaboration with ESO. Model: Nordic Telescope Group. Photo: ESO.

Memoranda for Mountaineers

Some hints for NOT users

L.O. Takalo

Having worked at NOT for 16 months during its commissioning period and having used the telescope, I would like to make some comments hopefully useful for other NOT users.

The telescope control system is easy to use and possible to learn in a couple of nights. Note, that there are no night assistants at NOT, so the astronomer will do all the work. In order to use the NOT efficiently, there should be two persons at the telescope all the time.

The seeing at NOT is very good. It is helpful to use the observing wall gates. Weather permitting, they should be opened a couple of hours before observing and kept open, at least, half an hour after the upper hatch has been opened. Of course, they can be kept open all night if the wind speed is not too high, but even keeping them open only as indicated above, the dome temperature will become the same as the outside temperature. Also, if the night temperature changes a lot one should check the telescope focusing during the night. Using the CCD, this can easily be done with existing commands in the CCD control system.

One should not take integrations much longer than 20 minutes with the CCD camera because of cosmic ray contamination.

Using the current guide TV camera, one can see objects down to magni-

tude 17 on the TV screen. One can center objects fainter than this to the detector diaphragm using the CCD camera. For an experienced NOT user this takes a few minutes.

It will speed your observing if you have selected your guide stars before coming to the NOT. Best guide stars are stars with magnitudes between 10 and 13. The guide stars should be selected from an area between 7 and 20 arcminutes East, West or North from your object. You can use the guide star's coordinates (RA, DEC) or the guideprobe coordinates (X, Y). The guideprobe center is at X=121630, Y=116780, and the scale is 0.0073 arcseconds per guideprobe unit.

The CCD camera filter wheel has space for 6 filters. It helps, if you plan in advance which filters to use (check with the NOT staff what is available).

Please, inform in time.....

Lars Olof Lodén

The staff members at NOT would like to urge the scheduled observers to send information, far in advance of the observing run, about the auxiliary equipment desired and also about relevant details concerning this equipment, like, for instance, filter combinations. It might well happen that a certain filter is not available at the telescope, and in that case there

should be time for discussion and decision about alternative solutions. Under ideal conditions the filter selection should be indicated already in the observing time application. In cases of faint objects for which guiding is necessary, it is a good idea to preselect a few presumptive guide stars. The appropriate positions of guide stars for various types of observations cannot be described in simple terms, but as a rough general rule they should, ideally, be situated somewhere between 7 and 12 arcminutes from the centre of the object. Estimated optimum V magnitude is about 10 - 13.

Change of auxiliary instruments is most easily performed during daytime, as is the case for changes of filter sets. In some cases it may be necessary for the observers themselves to assist at these procedures. This situation frequently occurs in connection with weekends or holidays when the small technical staff may be further reduced and even completely absent. Therefore, it is highly important that the observers arrive at least one day in advance of the first night of the run.

It is also important that the observers have finding charts, standard object lists, and similar items well prepared in advance as there are small possibilities to do it at the observatory itself. It has been mentioned before that the observers should bring their own diskettes and magnetic tapes. If, for some reason, an observer should have no possibility to bring a tape of her/his own, this should also be reported to the local staff in advance. At some occasions the observatory is short of tapes and has no one left for sale to a guest observer. The price of a tape is at present 5000 pesetas and the payment should be made in cash.

Computer system upgrading

Kim Steenberg

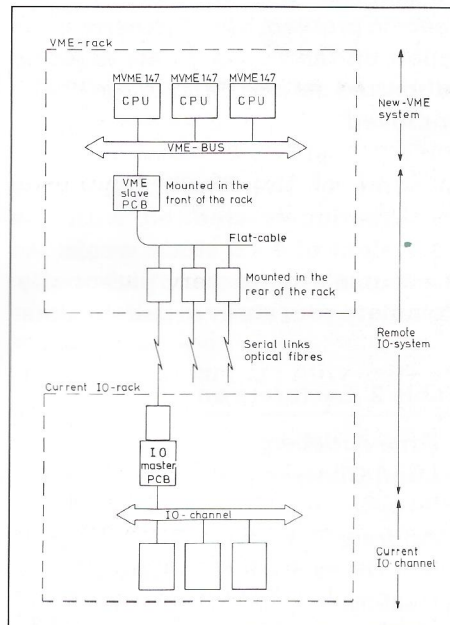
The Nordic Telescope Group at Risø and the operations group on La Palma are presently working jointly on an upgrading of the control computer system at the NOT.

The old system was designed on the basis of the state of the art in 1984. It has a Nord-100 16 bit master computer with four 16 bit VME Motorola microprocessors. This system is presently in use on La Palma. It is heavily loaded. Crashes of the software or communication problems occasionally occur. The communication network is sensitive to disturbances. Maintenance is tedious since the programs of the VME subunits are placed in EPROMs that must be programmed at every update.

The development within computer technology has been very fast. Today, 32 bit computers with efficient operating systems are easily affordable. It has therefore been decided not to spend further development time on the existing 16 bit equipment but to install a new 32 bit system. The new system will have three Motorola 68030 microprocessors placed in a common rack and working in parallel. These three computers will replace the former five computers. It is expected that the new system will be about ten times faster than the old system. The new system will communicate with the I/O units via optical fibers that are immune to electromagnetic interference.

Software

It is not necessary to write new software. The old software, written in Pascal, can still be used, but some modifications are required since there are differences in the operating systems. For the new system, OS/9 will be used. The conversion of the software is presently being performed jointly by the operations group on La Palma and the Telescope Group at



Architecture of new control system

Risø. Niklas Holsti on La Palma converts the part of the software that was formerly running on the Nord-100, whereas Ingvar Svårdh at Risø converts the software that was formerly on the VME units.

Installations

The computer interface to the operator will not be changed at this time. At a later stage it will, however, be possible to introduce a graphical user interface. The cabinet for the Nord-100 in the electronics room will disappear and will leave more space for other equipment. The old alt/az and support VME racks will be removed from the electronic cabinets in the electronics room. Also, the VME control computer integrated in the adapter will be taken out. All of these systems will be replaced by a single computer cabinet (33x50x50 cm³) that will be placed in the electronics room.

Time schedule

The new equipment has already been delivered and the software conver-

sion is essentially terminated. The complete software package was tested on La Palma in the beginning of June. The electrical hardware for remote I/O communication via optical fibers is designed and the printed circuit boards are now being generated using Orcad software at the Telescope Group at Risø. Installation will take place during full moon in the end of July and in the beginning of August. The new encoders (described elsewhere) will be connected to the system in September. We expect that the telescope will be running with the new computer system from the beginning of August, but during the time of running-in, it will still be possible to switch to the old system.

What will astronomers experience?

In the first phase, the new system will merely replace the existing one. In fact, during the first few weeks, a certain number of malfunctions and troubles can be expected. Obviously, we shall do our utmost to limit the problems as far as possible, but we ask for understanding from the visiting astronomers during that period.

Thereafter, from September, a period with higher reliability can be expected. It is possible that a few bugs in the software from the old system are transferred to the new system, but the reliability should gradually increase.

In the same period, the new incremental encoders are integrated into the control system. Also, the control of the rotating building will be included in the new computer system.

After the full integration and running-in of the new system, we expect higher reliability, faster responses, better blind tracking and higher slewing rates.

Nordic Research Course on La Palma

Jens Knude

In 1986 the Nordic Council of Ministers initiated a much needed practical Nordic cultural collaboration by funding a series of six systematic research courses in astrophysical observing methods. The previous five courses took place at existing hardware facilities in the Nordic countries. This, the first La Palma Course is the final of the first series and what could have been more appropriate than placing it at our new common Nordic observatory?

It is important that astrophysicists have some knowledge of the various techniques used to collect and reduce data in different wavelength regions. Hardly any individual institution possesses instrumentation working at all wavelengths required for scientific scrutiny, and collaboration thus becomes mandatory in the education of young researchers. The Nordic series of graduate courses has tried to serve this purpose by offering education in space and radio technology also.

The course in August is organized around the instrumentation presently available at the telescope, where ten nights have been granted by NOT's observing program committee. It must be a unique opportunity for the sixteen participating students to have access to such a large telescope during such a long period. They really get a chance to experience the life at an observatory - and probably to feel the frustrations of a cloudy night.

When the course was offered in January we had no less than 41 applications from the Nordic countries and Spain. The successful students may be found in Table 1 and they come from all the NOT countries, main land Spain and Tenerife.

Lectures will be given by a select group of researchers shown in Table 2 - in total the students will attend 43 lectures on eight subjects in two weeks, receive instruction in using the auxiliary instruments and in how the data are reduced to physically

relevant numbers. Last but not least they will learn how to control the big eye - and do their own observing.

Before leaving Roque de los Muchachos each student will give a 15 minutes presentation on some specific problem and, furthermore, a report on the reduced data must be submitted before the course is finally approved.

In some of the Nordic countries participation is credited with the equivalent of 4 - 5 study weeks - so the course's motto could perhaps be: Complete your study in half the time!

Table 1. Participants

Andersen, Michael	København
Crosby, Norma Bock	København
de Juan, Lourdes	Madrid
Djupvik, Anlaug	Oslo
Egonsson, Jim	Lund
Emanuelsen, Per-Ivar	Tromsø
Gullbring, Erik	Saltsjöbaden
Hänninen, Jyrki	Oulu
Hakala, Pasi	Helsinki
Jakobsson, Hans	Lund
Jensen, Marianne	København
Kjeldsen, Liv Torill	Tromsø
Knapen, Johan	La Laguna
Lainela, Markku	Piikkiö
Lindblad, Per	Saltsjöbaden
Vestergaard, M.	København

Table 2. Lecturers and Subjects

<i>Arne Ardeberg</i> Lund Observatory	Telescopes / The NOT in particular Galactic Photometry
<i>Andrew T. Young</i> San Diego State University, California	General Photometry
<i>A.J. Delgado</i> Instituto de Astrofísica de Andalucía	Calibration of intrinsic stellar properties
<i>V. Pirola</i> University of Helsinki	Polarimetry
<i>P. Linde</i> Lund Observatory	CCD imaging
<i>I. Pérez-Fournon</i> Instituto de Astrofísica de Canarias	CCD Observations of Extended Extragalactic Objects
<i>R.E. Nather</i> University of Texas, Austin	High Speed Photometry
<i>P. Nørregaard</i> Copenhagen University Observatory, Brorfelde	New Detectors

Additional Reading for the Sleepless

In addition to the torturous list of bed-time literature mercilessly published in the first issue, we now continue with the following hard-core sleeping pills:

Ardeberg, A. 1989: Some Properties of the Nordic Optical Telescope, Nordic Optical Telescope Scientific Association

Ardeberg, A. 1990: The Enclosure of the Nordic Optical Telescope, Nordic Optical Telescope Scientific Association

Thermal monitoring and control

High image quality demands a number of prerequisites. Most essential are a good site, high optical quality, high mechanical quality and firm control of thermal properties. We believe that our telescope has been erected at an exceptionally favourable site and that it has been equipped with a set of optical elements and a mechanical system which are highly sophisticated. In addition, we feel that our installations for thermal control include sufficient elements to allow an adequate thermal equilibrium.

The results obtained serve to prove that our expectations are well in line with observational reality. At the same time, these results indicate very interesting potential possibilities inherent to further improvements. In this regard, thermal monitoring and control seem to offer special promises. In order to investigate these possibilities in some detail, a small number of thermal probes have been installed to monitor continuously the temperature of some elements judged to be of major importance for resulting

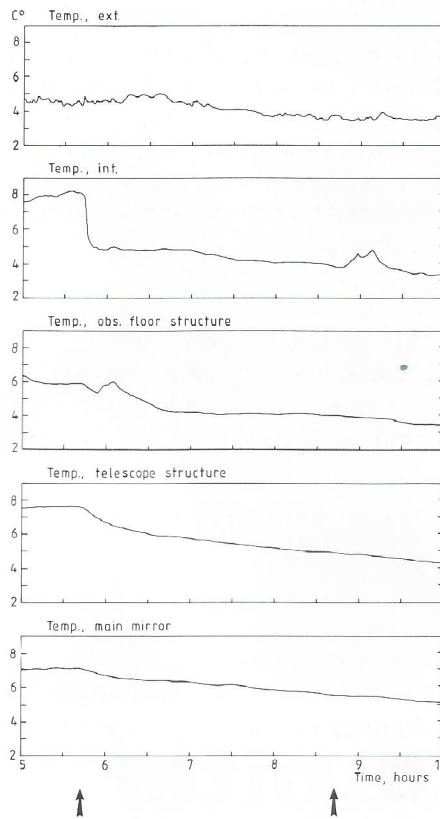


image quality. Results have been highly encouraging.

We conclude that there is every reason to design and install a system of thermal probes and activators, connected to a central unit actively monitoring and controlling the temperature of all elements influencing, directly or indirectly, resulting image quality. Such a system is now under conceptual design. The ultimate goal is to maintain all important telescope and instrumental units as well as the telescope environment at prevailing ambient night time temperature. We intend to return to this system in a forthcoming issue.

Run of temperature, over five hours, for some elements. Below the boxes, the left-hand arrow indicates the time of opening of hatch and wall gates. The right-hand arrow indicates time of arrival on the observing floor of three staff members, who left half an hour later.

Expanding space

As is well known to all who have visited our telescope, the office space at Cruz del Fraile is, at best, marginal. This is a fact which has, so far, been nicely, although not necessarily happily, accepted by operation staff as well as by visitors. Things have recently improved drastically. This is an improvement entirely due to the courtesy of the Instituto de Astrofísica de Canarias (IAC) and to local arrangement at the Roque de los Muchachos.

In the General Services building, close to the Residencia, we have obtained two offices, with LEST offices in the same block. Both offices are spacious and, as an extra bonus, come with basic furniture and telephones (telephone jokes are invited). In one of these offices, we have added bookshelves and our supply of journals. We hope that visitors will

be frequent guests here. In the other office, staff will have its premises.

It is a pleasure to acknowledge, once again, the efforts of our friends Francisco Sanchez and Mary Barreto. Maybe we should offer them an igloo in Tromsø?

Safety

Some people tend to believe that observing with ground-based telescopes and safety are items not really compatible. We hope that this is far from true. Endeavouring to prove our point, we managed to get fully professional help. Göran Cedergren, Head of Safety Engineering at the Lund University, and a renowned authority, got interested in our project. Through his and the Univer-

sity's courtesy, a visit to the Roque de los Muchachos Observatory was arranged by the middle of June. Göran made a most detailed inspection, impressing staff with his sharp eyes. Still, we plan to give details of his forthcoming report in our next issue. Naturally, meanwhile, Göran's advice will be given prompt attention.



New CCDs

Good detectors and good friends are valuable assets in many circumstances. In the case of our telescope, the combination of such assets may turn out a real hit.

There can be little doubt that the CCD camera now in use has been of a value hard to overestimate. At the same time, we know that the useful field of our telescope is considerably larger than that covered by our present CCD chip with its 2.5×10^5 pixels, squares with 27 micrometres sides. Further, we know that larger chips can be acquired today, especially if butting can be accepted.

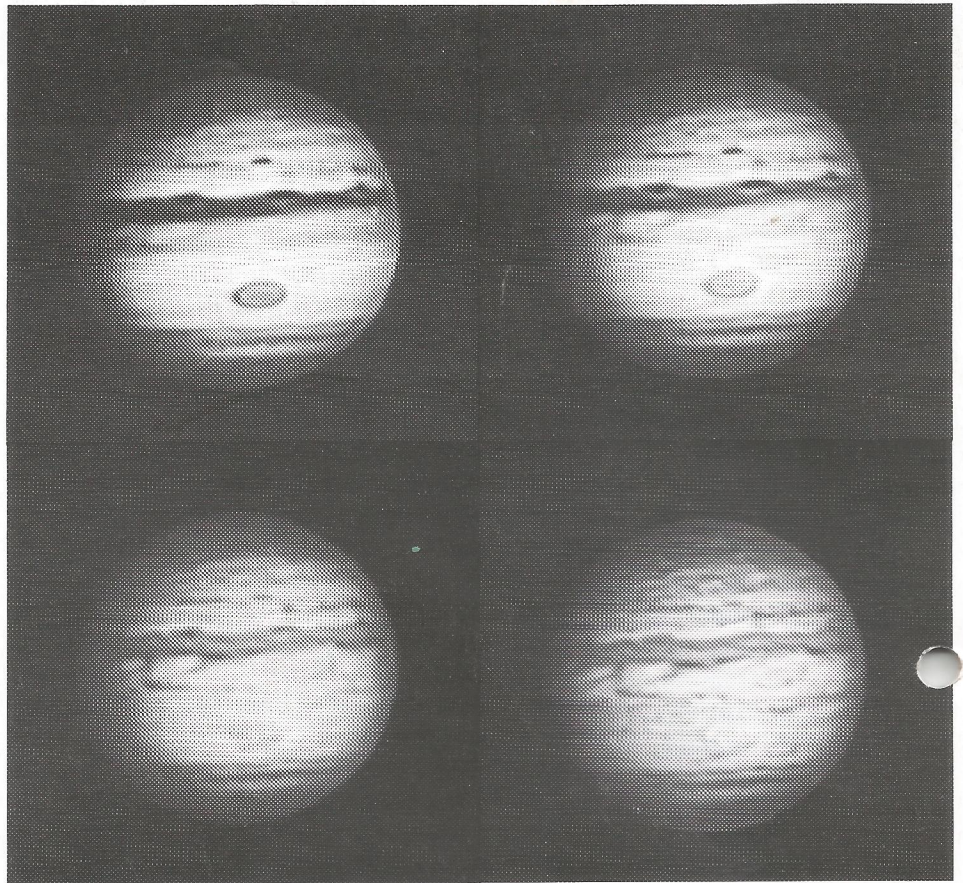
In collaboration with our friends at Brorfelde, we have agreed with Ford Aerospace on a contract for parts of batches of front-illuminated CCDs. Formats are 2000×2000 and 1000×3000 . We hope that there will be reason to come back with more details in the near future.

Clumsy?

Maybe you run around with a terrifically important scientific project, for which you urgently need some adequate instrumentation currently not available. You know what you want an instrument to do, and, basically, how to do it, but how to construct this instrument..... We suggest that you contact the Nordic Telescope Group. We offer (free of charge!) some initial advice and comments to get your plans tracking. Further help is also possible, but then you should bring your rich uncle.

New filters for the Stockholm CCD

In addition to the narrow band filters mentioned in NOT News Nr 1, two new redshifted $H\alpha$ filters are available. Central wavelengths are 6600 and 6620 Å and the FWHM is 40 Å. A filter with central wavelength 6580 Å is on order.



Jupiter

Short exposures of Jupiter taken with the Nordic Optical Telescope and its CCD Camera. From upper left to lower right, frames have been taken through the B, V, R and Z filters, respectively. Images have been enhanced with the Lund Observatory Image Processing system. Exposures: Hans Kjeldsen. Image processing: Peter Linde.

See you in Copenhagen.....

Following the first period of scheduled scientific programmes at the Nordic Optical Telescope, plans are being developed at the Nordic Institute for Theoretical Astrophysics for a workshop centred on Astrophysics with the NOT. Planning is under auspices of Bernard Pagel. His tentative schedule aims at a meeting, at the NORDITA premises in Copenhagen, in April 1991. The week of April 8-12 seems a hot guess. Items for the workshop include telescopes, instrumentation and topics in modern astrophysics. We hope to be able to present more details in a forthcoming issue.

