Figure 2 shows a 40-minute Hα image of the recurrent nova T Pyx. The FWHM of stellar images is 0.7″, one of the best ever attained for such a long exposure time through a narrow-band filter. The image shows in exquisite detail the debris from a previous outburst and will be used together with spectral information to determine to which historical outburst the surrounding material refers, and hence to derive a new, better estimate of the distance. Figure 3 is a 0.9″ seeing, 30-minute [NII] image of the young double cluster NGC 1850 in the LMC and shows extended filamentary emissions around the cluster. These are very likely the remnants of supernova explosions in the main cluster, which is only 50 million years old. Shock waves from supernova explosions were invoked as the probable cause of the formation of the much younger companion cluster (*Ap. J. Lett* 435 L43.

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Ghost Analysis and a Calibration Database for the Long Camera of the CES

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1. Introduction

We present recent improvements and changes at the CAT and CES, mostly performed during the telescope idle period in September 1994. We also describe a new calibration database which has been installed in La Silla computers and an analysis of the ghosts found in our extensive tests.

2. CAT Telescope

The floor of the CAT dome was in a bad shape and unsafe for observers and night assistants. The floor panels were replaced.

The CAT telescope and the CES spectrograph were re-aligned and the primary mirror of the telescope adjusted. This intervention was requested to improve the CAT optical quality, in particular to minimise coma; with this intervention also a more stable and accurate pointing model has been achieved.

3. CES Spectrograph

Due to a major technical problem (abnormally high read-out noise) on CCD #30, mounted on the CES Long Camera, this was replaced by CCD #34 in October 1994.

The CES spectrograph was used, in combination with the Long Camera and CCD #30, to acquire a full set of calibration spectra. 140 Th-Ar and Flat Field calibrations were recorded with the RED path covering the range between 8990 and 5215 Å, while 80 frames were acquired with the BLUE path covering the 5200–3790 Å domain. In Table 1 and 2 a summary of the wavelength interval steps used in the RED and BLUE path is given.

The aim for the acquisition of the calibration data set was twofold:

(1) To allow an analysis of the spectrograph ghosts present in the wavelength domain commonly used by the observers.

TABLE 1: Summary of central wavelengths and steps used for the calibrations in the RED domain.

λc Beg	λc End	Step (Å)
8890	8500	70
8435	8110	65
8050	7330	60
7275	6670	55
6620	6070	50
6025	5925	50
5880	5340	45
5295	5215	40

TABLE 2: Central wavelengths and steps used for the calibrations in the BLUE domain.

λc Beg	λc End	Step (Å)
5200	4520	40
4485	4030	35
4000	3790	30

(2) To provide the potential CES users with a complete set of calibration data, to be used to better planning their observations.

We note that, although the presence of ghosts is known to be more serious when using the CES in combination with the Short Camera, we have preferred to perform the calibration set with the Long Camera, mainly because, as soon as a new thinned detector will be available at La Silla (March 1995), the Short Camera will be decommissioned and only the Long Camera will be offered to the users.

The spectra were acquired with a nominal resolving power $R = 10^5$ and a decker height of 5 arcsec. Although the CES users are recommended to use a longer decker, a short decker was preferred because this facilitates the separation of those Flat Field (FF) ghosts falling close to the science spectrum.

The central wavelengths of the calibration frames were chosen to ensure some overlap between adjacent spectral ranges. The FF exposures integration times were selected to give a peak intensity level around 10,000 ADU (one ADU corresponds to 2.8 electrons in the used configuration) in the extracted spectra, and the intensity maximum typically varies between 6000 and 14,000 ADU after extraction. Only at very blue wavelengths (i.e. below ~ 4000 Å) lower exposure levels were obtained, because the maximum duration of the FF exposures was fixed to two minutes.

Th-Ar integration times were set to obtain a level of at least 10,000 ADU in the strongest lines of the extracted frame.

One-dimensional spectra were extracted over a slit of 13–14 pixels, almost the whole slit height.

Because these frames may be very useful for the CES users to prepare their observing runs and calibrations, they are made available to the users' community. Both the original (2-dimensional) and the extracted (1-dimensional) files are stored as FITS files; they can be accessed and copied through ftp with the following commands:

```
ftp 134.171.81.6
username: anonymous
password: your ident as password
cd pub/ces/calib
get README
binary
get Mλc.ND
```

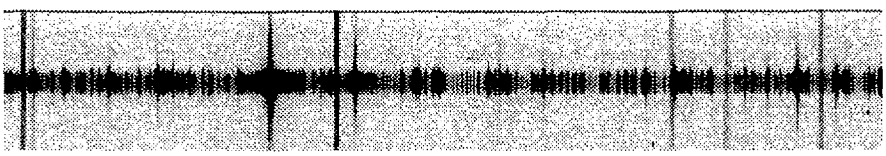

Figure 1: *Two-dimensional image of the Th-Ar exposure centred at 6470 Å.*

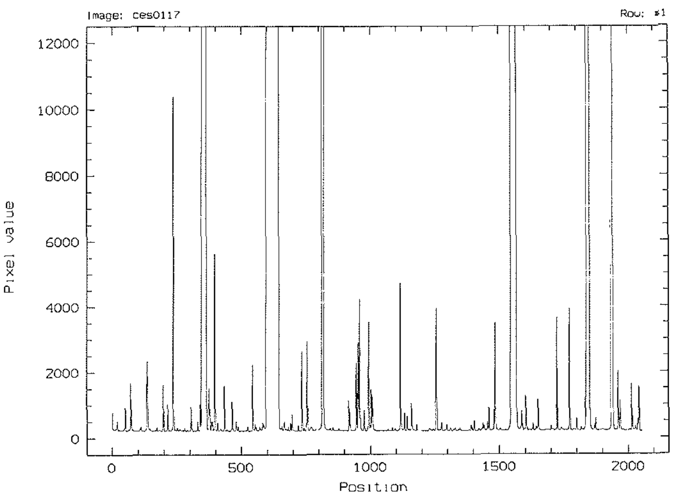

Figure 2a: *Extracted spectrum of the Th-Ar exposure centred at 6470 Å.*

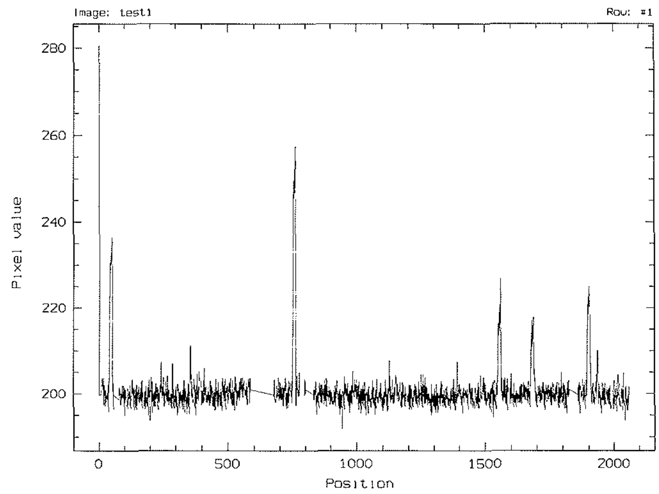

Figure 2b: *Ghost spectrum for the same region as in Figures 1 and 2a.*

After the transfer has been successfully completed, you may exit with

quit

The labels describe: M = FF or TH for Flat Field and Th-Ar exposures respectively

λc the central wavelength (in Å)

N = 2 or 1 respectively indicate the two- or one-dimensional files.

As an example, FF5415.2D will be the two-dimensional Flat Field frame at 5415 Å central wavelength. The names of all the stored frames are given in the README file, which also contains suggestions and advices for the use of the database.

The extracted spectra can be used by the CES users and by the technical crew to monitor the calibration procedures, the ageing of the lamps as well as the functioning of the neutral density filter wheel.

Note that complete descriptors (including integration time and neutral density filter used) are given only in the 2D files.

4. Ghosts

In the course of the ghosts' inspection, we have used both the 2D and extracted images. The 2D images were displayed using very low cuts (from 195 to 250 ADU, note that 191 ADU was the CCD BIAS level) and the inspection was carried out visually. When ghosts were noticed the 1D files were checked.

Hereafter we give some general remarks which came out from the tests. Observers are strongly invited to analyse the spectral region of interest before starting their observations.

4.1 Th-Ar ghosts

These ghosts are easily identified by displaying the 2D frames with very low cuts. In Figure 1 an example is shown: TH6470.2D with cuts between 195 and 250 ADU. In this frame we may distinguish two different effects:

(i) Strong, saturated lines: they produce x-elongated images, and are characterised by a stronger intensity in the slit centre, decreasing towards the edges.

(ii) Thin lines, having uniform intensity and extending over the whole CCD window. These lines are real ghosts. They are probably due to the reflection of strong adjacent Ar lines. No corresponding ghosts are seen in the FF exposures. They are present in the whole RED do-

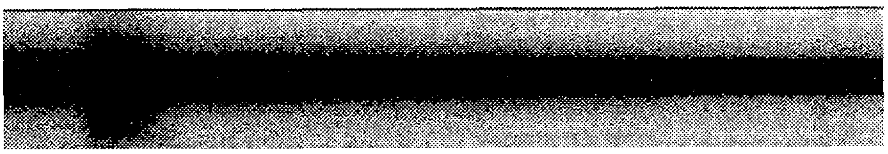

Figure 3: *Two-dimensional image of the FF centred at 5865 Å; note the presence of a FF ghost in the blue part of the spectrum.*

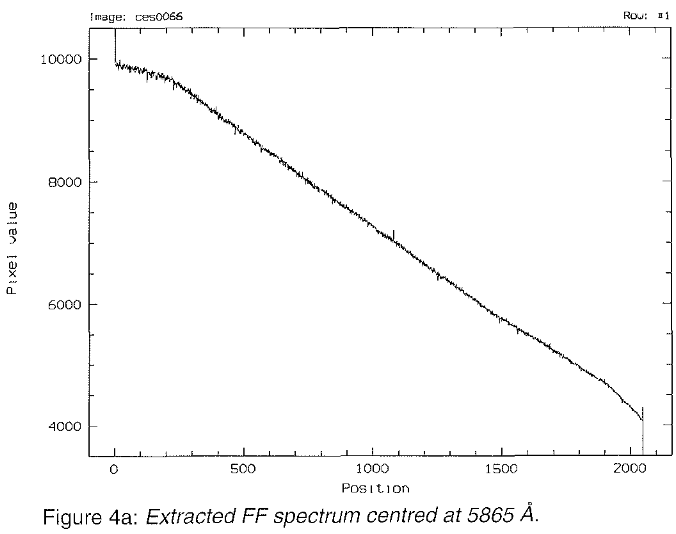

Figure 4a: *Extracted FF spectrum centred at 5865 Å.*

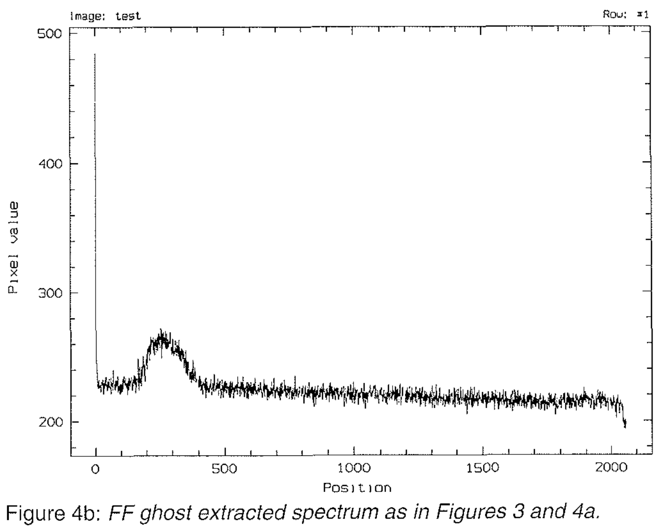

Figure 4b: *FF ghost extracted spectrum as in Figures 3 and 4a.*

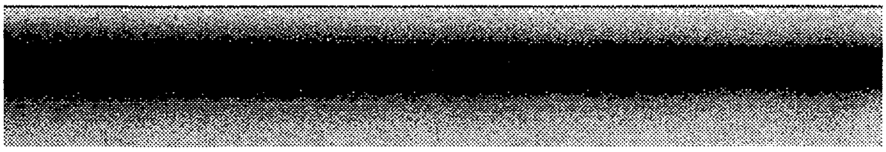

Figure 5: *Two-dimensional FF spectrum centred at 7870 Å.*

main, at virtually all wavelength settings, but their number and intensity increase with the wavelength; none are reported below 5000 Å.

Although Figure 1 could suggest that these ghosts may seriously affect the wavelength calibration, we would like to emphasize that in most cases their presence is negligible. Their intensity is typically much lower than that of true Th-Ar lines. This can be seen directly from Figures 2a and 2b. In Figure 2a the extracted spectrum of Figure 1 is presented (it will be TH6470.1D in the present notation); in Figure 2b the 'ghosts' spectrum for the same region is shown, obtained by extracting the spectrum on the side of the slit and taking away the contribution of the strong, saturated lines.

The presence of these low-intensity ghosts will therefore be most critical in those regions in the RED domain where the paucity of suitable lines makes the wavelength calibration difficult. A careful inspection of the calibration frames is always suggested in the reduction phase.

For several RED settings we have taken multiple exposures slightly shifting the central wavelength (typically by 5 Å). In all the cases the Th-Ar ghosts appear at constant wavelengths.

4.2 Flat Field Ghosts

The presence of ghosts in the Flat Field may be very critical, because their presence may produce uncertain results, changing for instance the shape or the equivalent widths of spectral lines.

FF ghosts were also identified visually using suitable (low) cuts, and it was found that their presence is confined to the spectral range 6170–4560 Å. Most of them fall at the side of the spectrum, thus not influencing the astronomical results for point-like sources.

Unfortunately, some of the FF ghosts do fall over the spectra. In Figure 3 the FF centred around 5865 Å is shown; a ghost is clearly present. In Figures 4a and 4b the extracted FF spectrum and the extracted ghost (the ghost image was extracted on the side of the slit) are shown: the ghost intensity is ~ 0.5 per cent of the FF intensity. Notice that in the extracted FF spectrum no 'bumps' are evident at the pixels corresponding to the ghost.

The presence of FF ghosts is limited to grating angles comprised between 273.5 and 275 degrees, which could suggest that they are due to the grating itself, however, in other grating positions encompassing this range, they were not recorded.

Although their intensity is very low and they are not clearly detectable in the extracted spectra, some care should be taken when the ghost is going to overlap over a spectral line of interest and in very high S/N-ratio observations.

A list of FF ghosts cannot be provided because, unlike Th-Ar ghosts, FF ghosts are *not* at a constant wavelength, but they shift by only a few pixels when changing the λc by several Å. This characteristic is on the other hand quite important, because if the presence of a FF ghost must be avoided at a given wavelength, this can be done by slightly shifting the required λc.

An additional, interesting feature emerges from the comparison of Figures 5 and 6, which show FF exposures taken at 7870 and 4310 Å respectively. The spectra are shown with the same cuts, and they have similar intensity. The level of diffuse light (clearly visible as hazy background out of the slit), is higher in the Blue spectrum. This is a general feature and it is not surprising: in general blue ranges are more sensitive to diffuse light, mostly due to enhanced scattering by dust in the spectrograph optics.

Acknowledgements

This work could not be achieved without the help of the La Silla TRS and Astronomy Support departments. A special thanks goes to the many CAT+CES Visiting Astronomers, who have, with their suggestions, pushed for the construction of the calibration data base.

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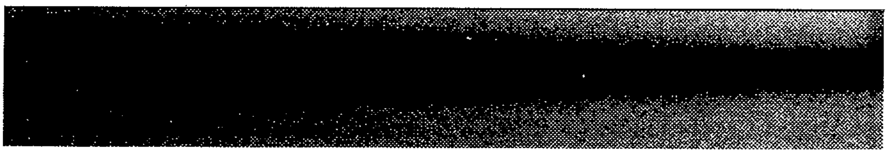

Figure 6: *Two-dimensional FFspectrum centred at 4310 Å. The cuts are the same as in Figure 5: note the higher level of diffuse light in the 4310 Å frame with respect to the 7870 Å one.*

ERRATUM

Figure 1of the article "New Holographic Grating for the B & C on the ESO 1.52-m Telescope", published in *The Messenger* No. 77 – September 1994, had incorrect labelling of the x-axis. The correct figure is shown here.