A new High Resolution Spectrograph at the NOT

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ABSTRACT

Several groundbased programs to support MONS are being considered. Some of them involves spectroscopy. An instrument that could be an important part of such programs is described here. It was recently installed at the NOT, La Palma.

1. Introduction

To determine basic stellar parameters for primary MONS targets high quality high resolution spectra are needed. With the large format CCD detectors now available, it is possible to measure the whole optical spectrum from 350–850nm in one single exposure with a resolution around R=50,000. An instrument of this type, the FIber Echelle Spectrograph (FIES), has just been installed and tested at the Nordic Telescope at La Palma. We expect this instrument to be able to contribute to the MONS project, when it is fully operative.

2. The spectrograph

The instrument was completed in a laboratory version in August 1998 and the first spectra were presented at a NOT meeting (Frandsen & Lindberg 1999). It was afterwards decided to install FIES on the Nordic Telescope on a platform on the side of the telescope. The instrument is designed in a similar way as the FEROS spectrograph at La Silla (Kaufer et al. 1999). It is coupled to the telescope via an optical fiber. Another fiber feeds the spectrograph with light from a reference source. The detector does not provide room for more than these two interleaved spectra. FEROS includes an image slicer, which is possible as the interorder distance is larger. This again is due to a large detector (2k$\times$4k) giving room to wider orders. The projected fiber diameter on the sky for FIES is 1.4”. FEROS has a fiber which projects to us much as 2.7”, partly due to the image slicer and partly due to the smaller telescope.

3. Installation

The large optical table (3m$\times$1.2m) was put in place at the Nordic Telescope during technical time in February 2000. An inner enclosure protects the optical components against dust and also against light in the

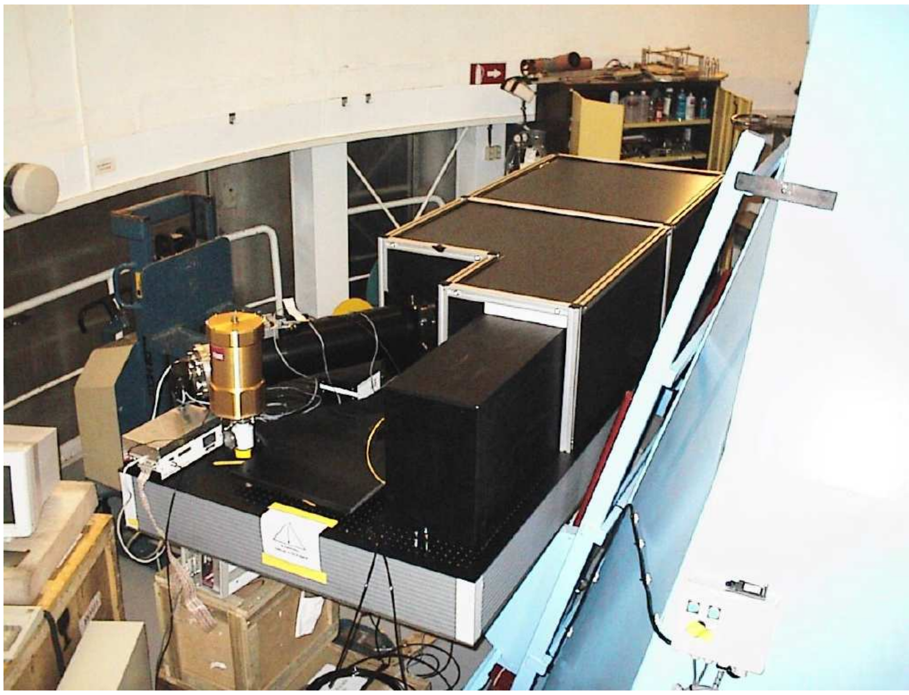

Fig. 1.— The spectrograph in its 'coffin' mounted on the side of the telescope

dome. The table plus optics has a weight around 900 Kg. The telescope does not seem to be affected by the additional weight. In Fig. 1 one can see the table and the black enclosure on the supports. There is a lift that can move the table up so that traffic in the dome is not blocked. Fig. 2 shows the spectrograph with the lid off, so that most of the optical elements are visible.

The fiber was mounted on one side of the telescope adaptor, opposite to the standby camera. Target acquisition takes place using the standby camera. The fiber position in the field of view of the standby camera has been determined to a precision of one pixel. Using these coordinates the target star is chosen with the cursor and the telescope automatically moved to a position that brings this star to the position of the fiber. Repeated tests show that the target star is then on the fiber, when redirecting the light in that direction and only need to be centered.

Presently there is no fiber viewing arrangement and the star was centered on the fiber using a small diode photometer that can monitor the flux at the output end of the fiber by sliding a mirror into the beam. Also a value for the best focus was found using the photometer.

The fiber can easily be removed or reinstalled on the telescope. The fiber end includes a focal reducer lens with a mirror that reflects light that do not enter the fiber. This unit is placed in V-block and firmly clamped on. The fiber position repeats very accurately when remounting the fiber unit, so that the same position on the standby camera can be used. It only takes a couple of minutes to mount the fiber.

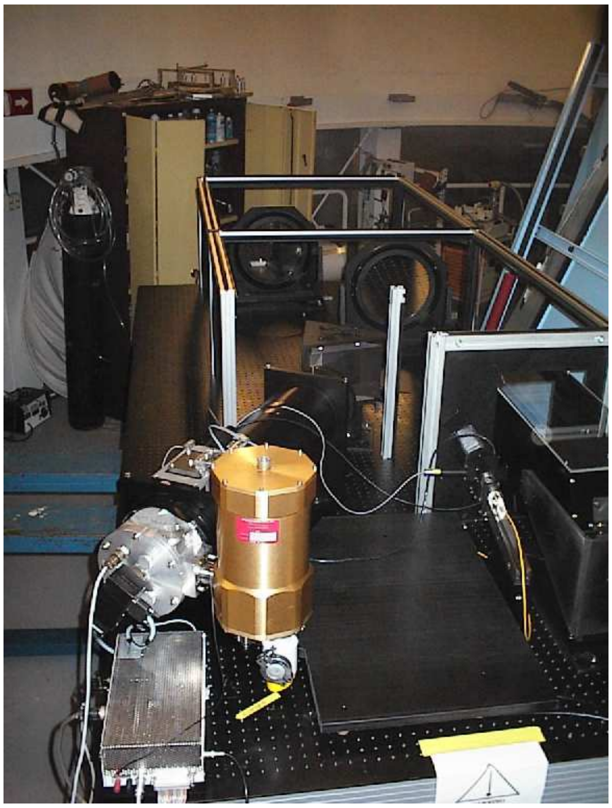

Fig. 2.— The content of the optical table is seen in this picture: the two collimating paraboloids, the prism, the camera at the left with the CCD camera at the end, the fiber entry and the Echelle grating at the right

4. Results

It was not possible to get the proper CCD camera ready for the first tests, so an old, small CCD camera was mounted instead. Therefore only a part of the spectrum, covering one half order for around 30 orders, could be observed. An example of one of the first spectra obtained (Fig. 3) is shown. The spectrum consists of pieces of the spectrum in the range 400–530nm. The star is Arcturus. The 'dots' between the stellar spectrum are Thorium lines from the reference source.

Not much light is seen in the blue part, partly due to the spectral type of the star (K star) and partly due to the detector, which has a poor blue response.

To get an idea about the performance of FIES we observed a star, which was observed with FEROS. The star is HD 128167, and a FEROS spectrum was kindly supplied by Jens Viggo Clausen. In Fig. 4 a small part of the spectrum observed with FEROS and with FIES just redward of Hβ is shown with an arbitrary zero point on the horizontal axis and the number of electrons recorded per pixel bin on the vertical axis. The pixel size for FIES is not small enough to reach the R = 60,000 resolution, and consequently the resolution is comparable for the two spectra. Correcting for the differences in parameters: (D=2.5m vs 1.5m, QE=40%

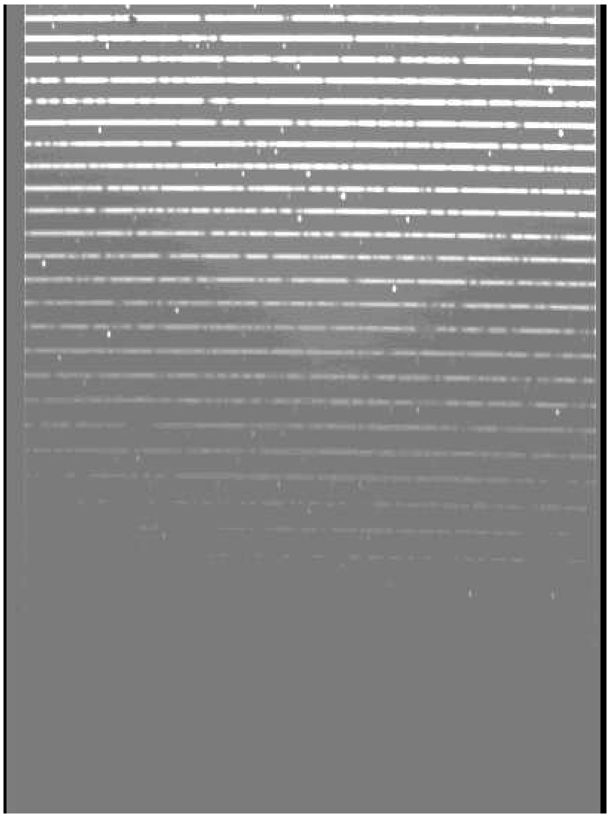

Fig. 3.— Arcturus spectrum. The dots here and there are lines from a simultaneous Thorium spectrum.

vs 98%, t=300s vs 120s etc.), we find that the total efficiency of FIES is about 1/3 of FEROS. As the FIES spectrum is from the night of first light and the seeing and focusing was far from optimal, this is a good first shot at reaching the nominal efficiency, which is about twice the present result = 2/3 of FEROS. The image quality is more important for FIES than for FEROS due to the smaller projected area on the sky of the FIES fiber.

5. Future plans

During a second visit to the NOT a large format CCD chip will be installed. An outer temperature regulated enclosure will be built and optics that permit monitoring of the fiber entrance with the standby camera installed. Several minor improvements are planned as well. The spectrograph should then be ready for general observations.

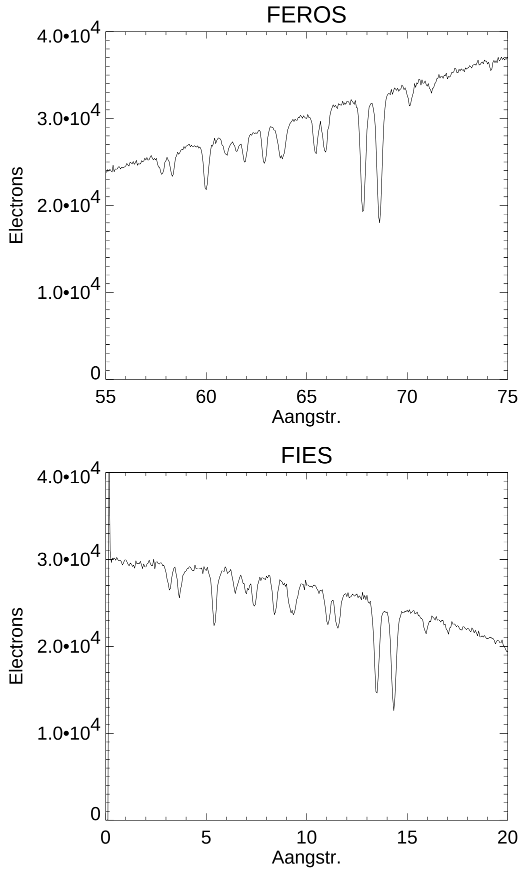

Fig. 4.— A small piece (20Å) of a spectrum of HD 128167, V=4.5, Spectral type F2V, in the far red wing of Hβ. The spectra were extracted using IRAF and have not been flatfielded.

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