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 Organisation Européenne pour les Recherches Astronomiques dans l'Hémisphère Austral  
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# La Silla-Paranal Observatory

## FEROS

### Commissioning of the New FEROS ADC

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## Table of Contents

<b>1</b>	<b>Documentation</b>	<b>2</b>
1.1	Applicable documents . . . . .	2
1.2	Reference Documents . . . . .	2
<b>2</b>	<b>Scope</b>	<b>2</b>
<b>3</b>	<b>Background</b>	<b>2</b>
3.1	An ADC for FEROS . . . . .	2
<b>4</b>	<b>The new FEROS ADC</b>	<b>4</b>
4.1	Transmission . . . . .	4
4.2	Correction as a function of airmass . . . . .	4
4.3	The spectra with the new ADC . . . . .	6
4.4	The impact on radial velocity determination . . . . .	7
<b>5</b>	<b>Conclusions</b>	<b>8</b>

## Abbreviations and acronyms

AD	Applicable Document
ADC	Atmospheric Dispersion Compensator
DIMM	Differential Image Motion Monitor
FEROS	Fibre Extended Range Optical Spectrograph
RD	Reference Document

# 1 Documentation

## 1.1 Applicable documents

The following documents in the exact issue shown are applicable documents. In the event of a conflict between what is specified in this document and in an Applicable Document, this document shall prevail.

<b>Ref</b>	<b>Document Title</b>	<b>Document ID</b>
AD1	FEROS User's Manual	LSO-MAN-ESO-22200-0001, Issue 77.0

## 1.2 Reference Documents

The following Reference Documents contain general information relevant to the FEROS ADC.

<b>Ref</b>	<b>Document Title</b>	<b>Document ID</b>
RD1	New ADC mode	Tech.Rep. LSO-TRE-ESO-75441-005 Issue 1.0
RD2	New ADC mode	Tech.Rep. LSO-TRE-ESO-75441-005 Issue 2.0
RD3	Final ADC Design	Tech.Rep. LSO-TRE-ESO-75441-005 Issue 3.0

# 2 Scope

This document reports on the tests which have been performed in April 2006 to commission the new FEROS ADC.

# 3 Background

## 3.1 An ADC for FEROS

FEROS is a fibre-fed high resolution spectrograph (see AD1). FEROS was initially designed to be used at the ESO 1.52m telescope. The projected fibre diameter onto the sky was 2.7 ". In 2003, FEROS was installed on the ESO/MPI(2.20 m telescope) with a different "plate scale" leading to a projected fibre diameter of

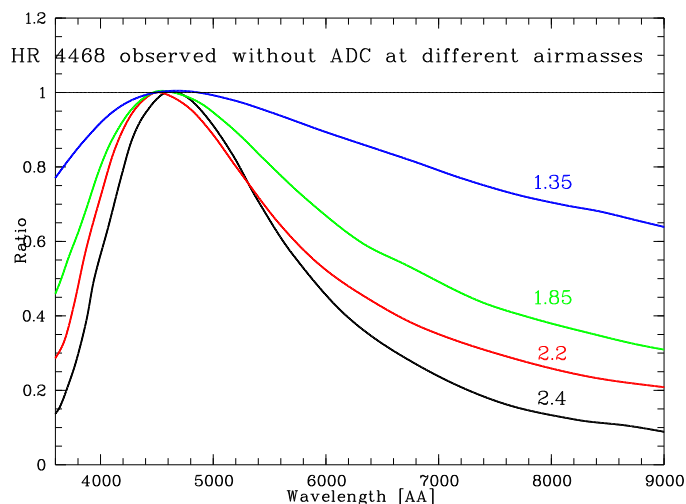


Figure 1: *HR 4468* : ratio of the spectrum of the star observed at a given airmass to the spectrum observed close to the zenith

1.8". At high zenithal distances, the losses become important as shown in Fig. 1, and the implementation of an ADC was mandatory.

A design of an ADC for FEROS was realized (see RD1,RD2,RD3) and the installation of an ADC was done in March 2005.

Prism transmission has been measured by acquiring SolarSpectra with the ADC IN and OUT during the middle of the day when the sky brightness is to a good approximation constant over a period of a few minutes, during which the exposures are acquired. The ratio shown below (Fig. 2) is from an ADC-OUT / ADC-IN sequence taken approx 3hrs before sunset. They are in the ratio ADC-IN/ADC-OUT. The plot provides an estimate of the absolute transmission curves. Close examination of the image shows that the total transmission of the TWO prisms is above 90% for wavelengths above 3900 Å. Below 4000 Å there is a strong fading of the transmission down to 50% at 3500Å due to the cement used to glue the two parts of the prism unit. An UV curing cement was incorrectly used by mistake during the manufacturing process. The ADC could be used anyway with a small efficiency decrease below 3900 Å. Meanwhile, a new set was ordered and tested successfully on our optical lab during March 2006. Installed in April a new commissioning was then required to confirm the final very good status.

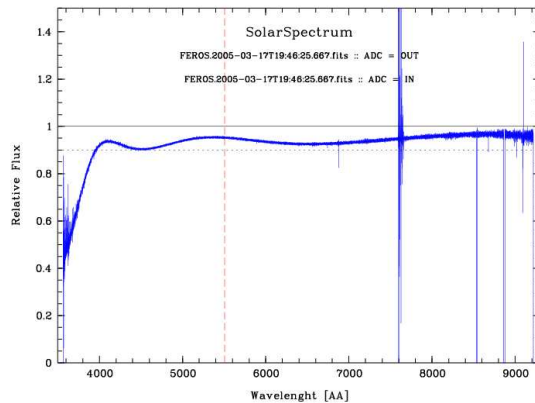


Figure 2: *Transmission of the 2005-ADC. Note the losses downward to 4000 Å*

## 4 The new FEROS ADC

### 4.1 Transmission

We took two spectra (with and without ADC) by illuminating the fibres by the daylight (solar spectrum) under the same assumptions as in the previous section. In Fig. 3, we plotted the ratio of the spectrum with ADC-IN by the ratio with ADC-OUT. Analysis of the figure shows that the transmission is above 90 %. It is also particularly important to compare the behaviour of the ADC at wavelength bluer than 4000Å . With the new ADC, the loss of transmission found with the previous ADC is no longer detected. The transmission of this new ADC is fully satisfactory and well within the specifications (see RD3).

### 4.2 Correction as a function of airmass

During the night 22/23 April 2006, 2 standard stars were observed at different airmasses. The weather conditions were not photometric and the DIMM seeing varied from 1 to 1.7 arcsec along the night. Therefore, losses could be expected even at low airmass. For each airmass value, 2 spectra were taken, one with ADC-OUT and the other with ADC-IN. To make the figure more visible, we made a polynomial fit to the continuum of the spectra to get rid of the telluric absorption features which do not cancel out properly. We then compute the ratio using these polynomial approximations.

On Fig. 4 we present the result for the star HR 4468. It is clearly visible that the

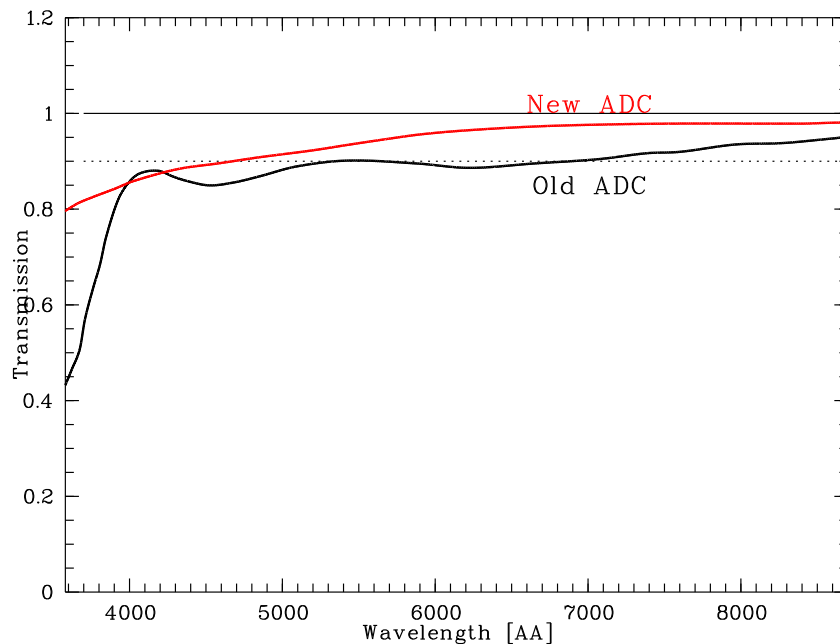


Figure 3: Transmission curves of the two FEROS ADC. The dashed line indicates a 90 % transmission. Note that the new ADC keeps a high transmission below 4000 Å.

influence of the ADC becomes significant already for an airmass of  $\simeq 1.35$ . It is also important to notice the good correction downward to 4000 Å

In Fig. 5, we plotted the same ratios for the star HR 4963. The increase in efficiency when using the ADC is confirmed both in the red and the blue part of the spectrum. A comparison of the Fig. 4 and Fig. 5 reveals that the intensity of the correction is slightly different. The main reason is that these stars are different spectral type (B9 for HR 4468 and A1 for HR 4963) leading to a different spectral energy distribution. Therefore the guiding was not done exactly at the same central wavelength. We should also take into account the fact the night was not photometric and the seeing rather bad. As a consequence, the corrections shown on these figures can give only a qualitative estimate of the correction given by the use of the ADC. However, it definitely confirms the need for applying the ADC at airmass larger than  $\simeq 1.3$ .



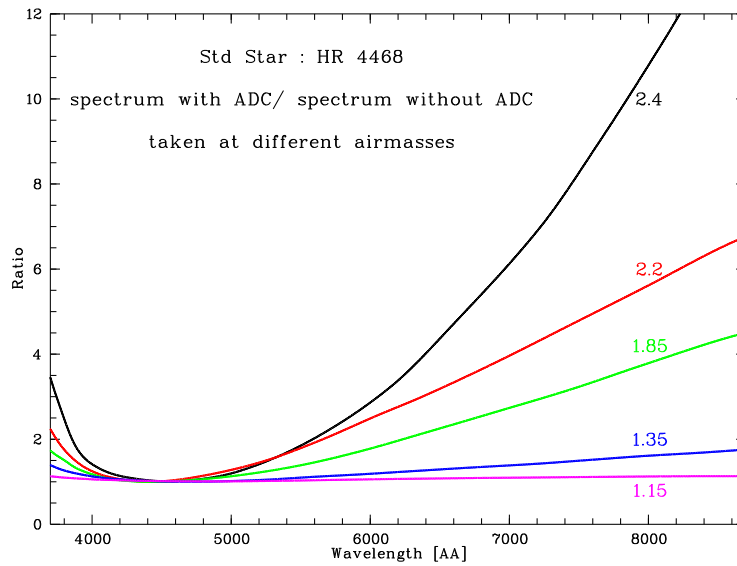


Figure 4: *HR 4468* : ratio of the spectrum taken with ADC-IN with the spectrum taken with ADC-OUT

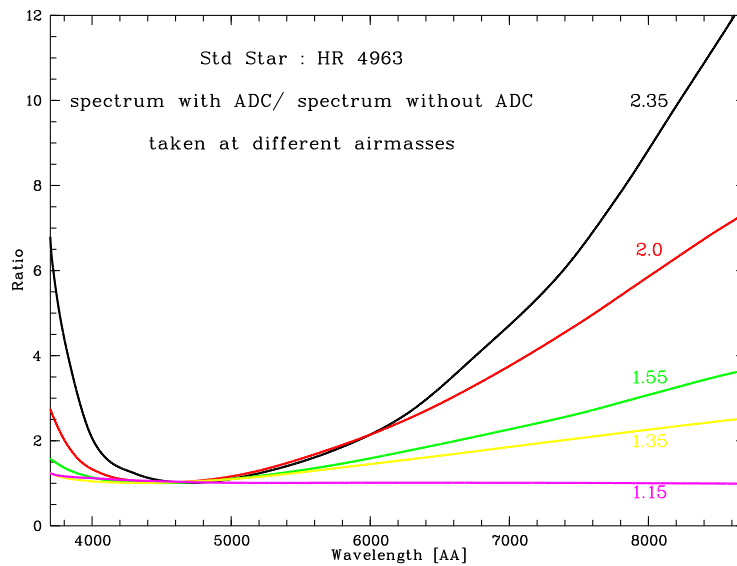


Figure 5: *HR 4963* : ratio of the spectrum taken with ADC-IN with the spectrum taken with ADC-OUT

### 4.3 The spectra with the new ADC

On Fig. 6, we have plotted spectra of the standard star HR4468 taken at different airmasses corrected by the response function by dividing them by a spectrum of

the star taken close to the zenith. The spectra in black represent the observation without using the ADC whereas the spectra in red show the spectra using the ADC. Fig. 6 shows clearly the gain in flux obtained when the ADC is used.

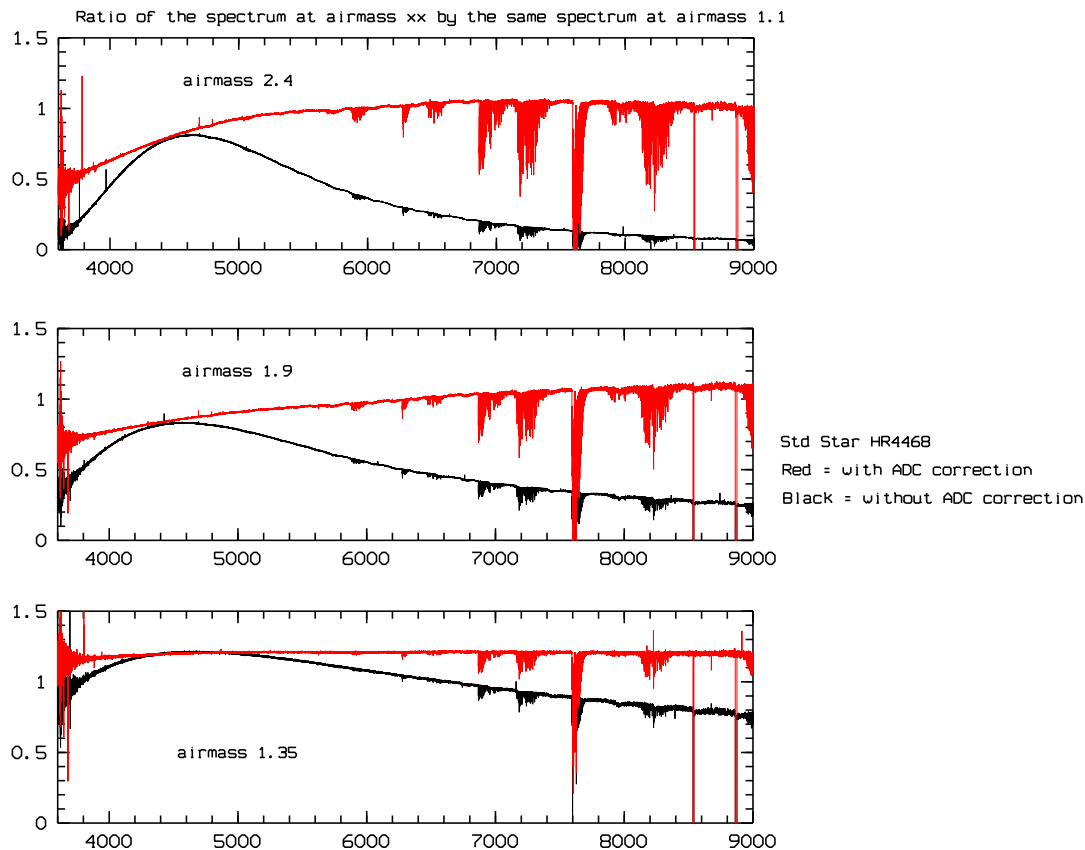


Figure 6: spectra of HR 4468 at different airmasses : in red with ADC-IN, in black with ADC-OUT

#### 4.4 The impact on radial velocity determination

We observed a solar type star (HD 2017129) at an airmass of 1.9 to estimate if the use of the ADC would lead to a shift in the determination of the radial velocity wrt. to the determination of the radial velocity when the ADC is not used.

We computed the 1D cross-correlation between the spectrum taken with ADC and the one taken without ADC. In Fig. 7, we show the correlation peak. A gaussian

fit to this peak gives a null central value indicating no significant shift when the ADC is used.

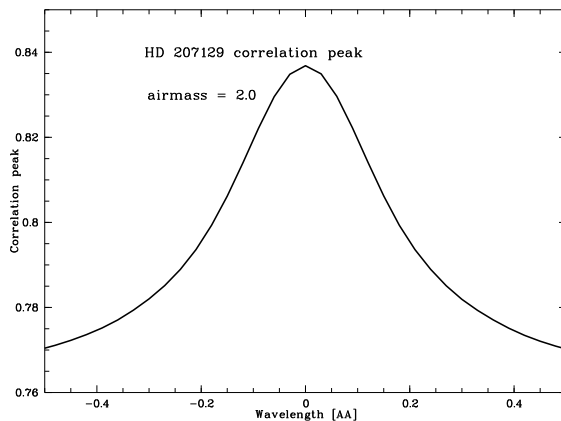


Figure 7: *HD 207129* : Cross correlation peak of the spectrum ADC-IN with the spectrum ADC-OUT. No shift is noticeable

## 5 Conclusions

The ADC is totally functional as design. Losses below 3900 Å no longer affect the blue efficiency. The ADC will have to be used for airmass greater than  $\simeq 1.3$  corresponding to  $\simeq 30^\circ$  of zenithal distance as expected on the design. However, this limit depends significantly on the spectral energy distribution of the source.