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A High Resolution Spectrograph at Weihai Observatory

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Abstract. Weihai Echelle Spectrograph (WES) is the first the fiber-fed echelle spectrograph in China. WES can provide data for the studies of metal abundance of stars, exoplanets researches and asteroseismology, etc. A brief description of its design and performance is given.

Keywords. Spectrographs, Radial velocities.

1. Weihai Echelle Spectrograph (WES)

The starlight is guided in the fiber-head (see Fig. 1) at the Cassegrain focus of 1m telescope. WES is mount in a constant temperature and mechanically isolated environment to provide an exceptionally stable echelle order image on the CCD (Pfeiffer *et al* 1998) for exoplanet searching by radial velocity (RV) method. WES adopts a white pupil design with a 92.5 mm beam collimated by two off-axis parabolic mirrors. The collimated beam is dispersed by echelle grating and then cross-dispersed by two prisms. The optical characteristics of the WES are listed in Table 1.

WES is mounted on a marble bench weighing about 1500 kg in the room on the frist floor inside temperature and humidity controlled. Its mechanical properties are optimized for compensating perturbations and thermal stabilization. The temperature of spectrograph box is controlled by circulatory water with constant temperature. A photograph of WES mounted on the optical bench for initial testing is shown in Fig. 2.

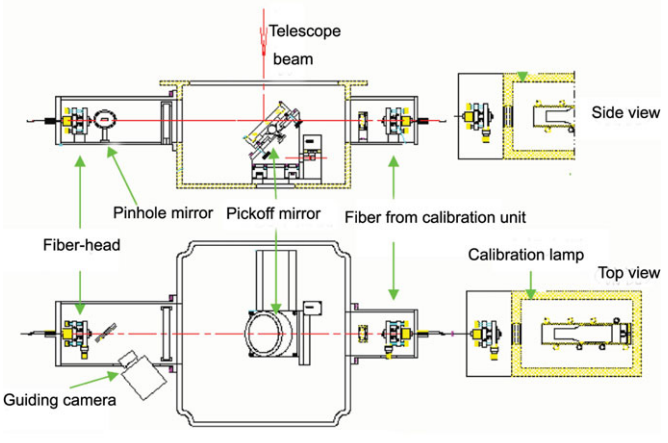

Figure 1. A schematic diagram of interface to the telescope.

Table 1. Main characteristics of WES.

Resolving power (at 550nm)	
Spectral resolution per pixel	0.044 $\dot{A}$/pix
R= $\lambda/\Delta\lambda$ without slit	40 000 (3.1 pix. sampling)
R= $\lambda/\Delta\lambda$ with slit	<57 000 (2.2 pix. sampling)
Wavelength range (one exposure)	373-970nm (continuous100 orders)
	373-1060nm (extended 107 orders)
Fiber unit	
Guiding CCD	Field of view $\sim 6' \times 6'$
Pinhole aperture	0.13mm (3.4″)
Fiber core	50μm
Spectrograph (white-pupil layout)	
Spectrograph beam diameter	92.5mm
Collimators focal ratio	F/10
Echelle grating	Newport R2.9 (71°), 31.6 lines/mm
Cross disperser	2 × LF5 glass prism, 41° apex angle
Separation between orders	11∼26 pixels from red to blue
Dioptric camera	
Camera focal ratio	F/3.3
Camera aperture	110mm
Detector	Andor iKon-L 936 2048 × 2048 13.5 μm pixels
Spectrograph total size	2.3m (L) × 1.85m (W) × 1.5m (H)
Temperature stablitiy	
Temperature change in one day	±0.05 °C
Temperature change in one week	±0.10 °C

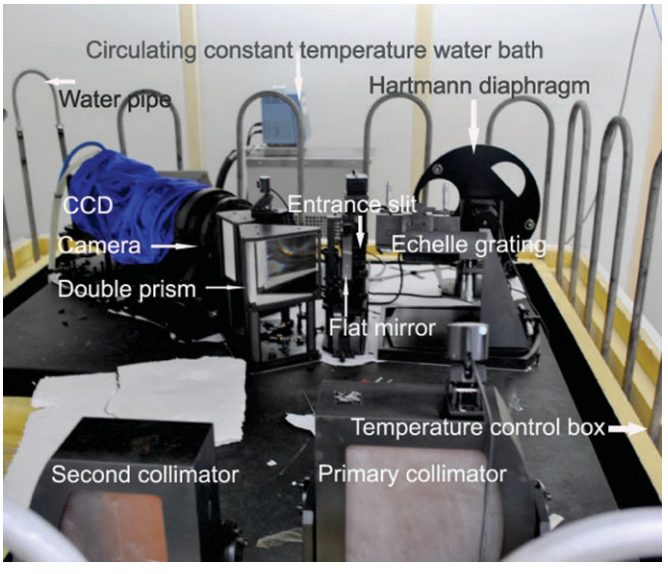

Figure 2. A photograph of WES mounted on the optical bench for initial testing.

2. Observations with WES

Table 2 summarizes the signal to noise ratio (SNR) of spectrum obtained on November 17, 2010 with a seeing of 1.4″. We acquired each spectrum in an hour with a resolution of R ≈ 40 000. A spectrum of 8.05 V-mag star (HD19445) with one-hour exposure produced a SNR of 106 at 550 nm. An iodine cell was placed in front of the fiber-head during observations of RV standard stars. By processing the data of HD113226 with the

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Table 2. Summarizes the SNR of spectrum obtained on Nov 17, 2010.

Objects	V-magnitude	Spectral Type	SNR at 550nm	SNR at 620nm
HD19445	8.05	A4	106	130
HD201889	8.04	G1V	83	102
HD201891	7.38	F8V	124	158
HD400	6.22	F8IV	229	280
HD6582	5.12	G5V	335	429

Notes: Each exposure time=1 hour, seeing $\sim 1.4''$, R $\approx$ 40 000.

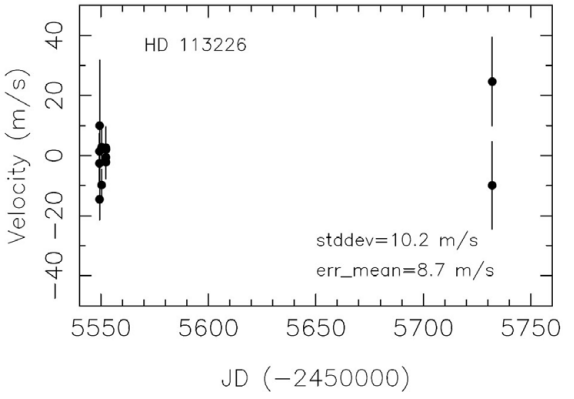

Figure 3. RV accuracy of WES tested by HD113226.

code developed by Bun'ei Sato, the RV accuracy of WES is estimated to about 10m/s in ∼200 days (see Fig. 3). The RV precision will be better after optimizing the code.

3. Summary

The estimated total throughput from the telescope focal plane to the detector is ∼17% in V band. The SNR for the 8^{th} Vmag star can reach 100 per wavelength bin in V band with seeing<$1.5''$, one hour exposure, R $\approx$ 40000. The RV accuracy of WES is estimated to about 10 m/s within half a year. In the near future, we will examine the RV accuracy within a few years time using the similar modeling technique that described by Sato *et al* (2002).

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