Characterization of the Atmospheric Dispersion Correctors from VLT/SPHERE.

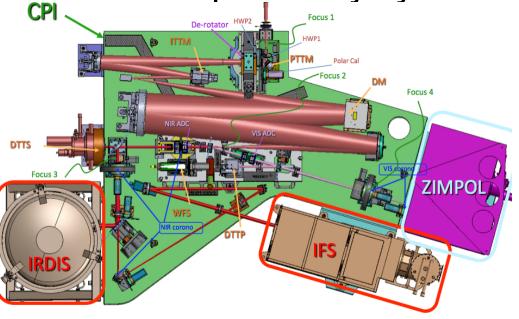
P. Hibon, K.Dohlen, A.Vigan, J.Milli, and the SPHERE Consortium

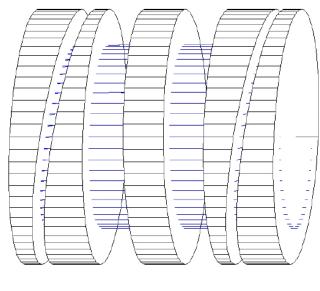
An Atmospheric Dispersion Corrector (ADC) uses a double-prism arrangement to nullify the vertical chromatic dispersion introduced by the atmosphere at non-zero zenith angles. The ADCs installed in the Spectro-Polarimetric High-contrast Exoplanet Research instrument were first tested in 2014. SPHERE was installed at the UT3 Nasmyth focus of the Very Large Telescope in April 2014 and first light occurred on May 4th that year. We give an overview of the characterizations and performance of the NIR and visible ADC units obtained on sky.

INTRODUCTION

The Spectro-Polarimetric High-contrast Exoplanet Research (SPHERE) instrument (Beuzit et al. 2008)

available on one of the Unit Telescopes of the Very Large Telescope (VLT) aims to unveil the mechanisms of formation and evolution of planetary systems. It saw its first light on May 4th 2014.





The two IR double prisms on either apodizer is located.

The Atmospheric Dispersion Corrector (ADC) corrects from the atmospheric refraction. SPHERE has two ADCs:

- one for the Infrared arm (the IADC)
- one for the Visible arm (the VADC).

Each ADC consists of two individually rotating double prisms located in a pupil plane and cannot be extracted from the optical path. One particular feature of the ADC control law used in SPHERE is its capacity to compensate for the fixed instrumental dispersion due to the wedge in the dichroic separator between the ZIMPOL path and the WFS path.

Adopted ADC requirements	
Humidity	0 to 95%
Wavelength range - VADC	500 - 900 nm
Wavelength range - IADC	950 - 2320 nm
Zenith Distance	1 < ZD < 60 deg
Airmass	< 2
Residual dispersion in IR atmospheric bands	< 1.2 mas
Residual dispersion in IR dual imaging filter paris	< 0.3 mas
Residual dispersion across the visible range	<10 mas

OBSERVATIONS

Description of the data:

- IFS data: Commissioning data. Stars observed without coronagraph, in direct imaging. IFS extended mode with YJH prism.
- IRIDS data: Classical imaging in broad-band H. ~ 40min exp. Time per sources.
- ZIMPOL data: Observe image position in different ZIMPOL filters

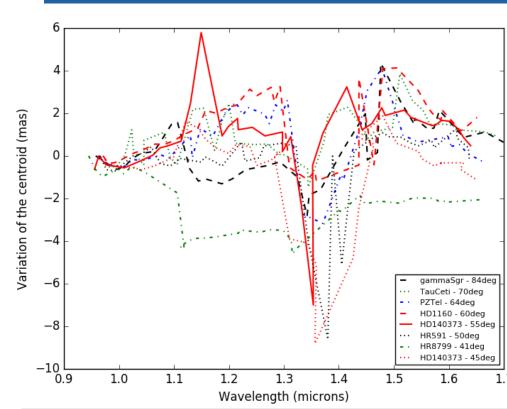
Compare image positions with flat-field coronagraph positions to eliminate the filter prism effect Use a constant reference filter in second ZIMPOL channel to

eliminate temporal evolution error Implement "ghost" observation after change of POSANG to

eliminate the ADC stability problem Data Reduction:

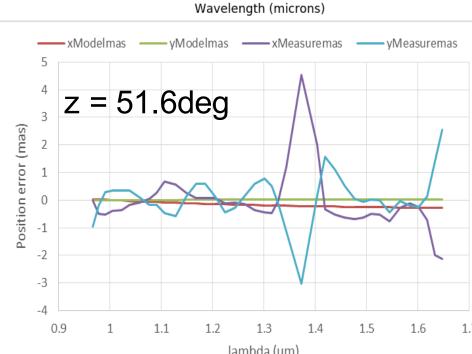
- IFS data reduced using the method and scripts described in Vigan et al. 2015
- IRDIS and ZIMPOL data reduced using the SPHERE DRH pipeline described in Pavlov et al. 2008

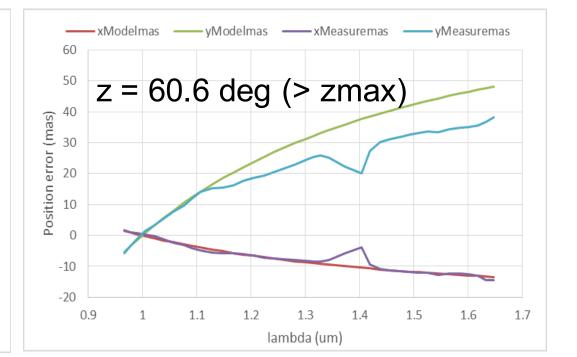
ADC Performance - IFS



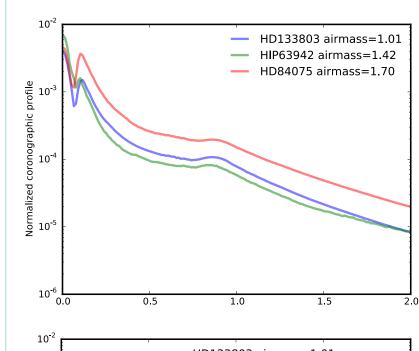
Comparison of the centroid dispersion for several stars observed at different elevations.

Expected effect between 1350nm and 1500nm due to atmospheric absorption. Performance within the nominal operating range (z<60 deg).

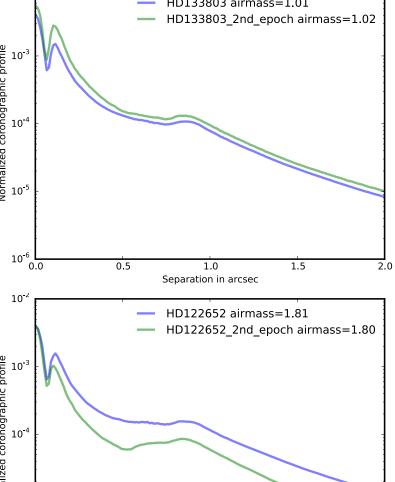




ADC Performance - IRDIS



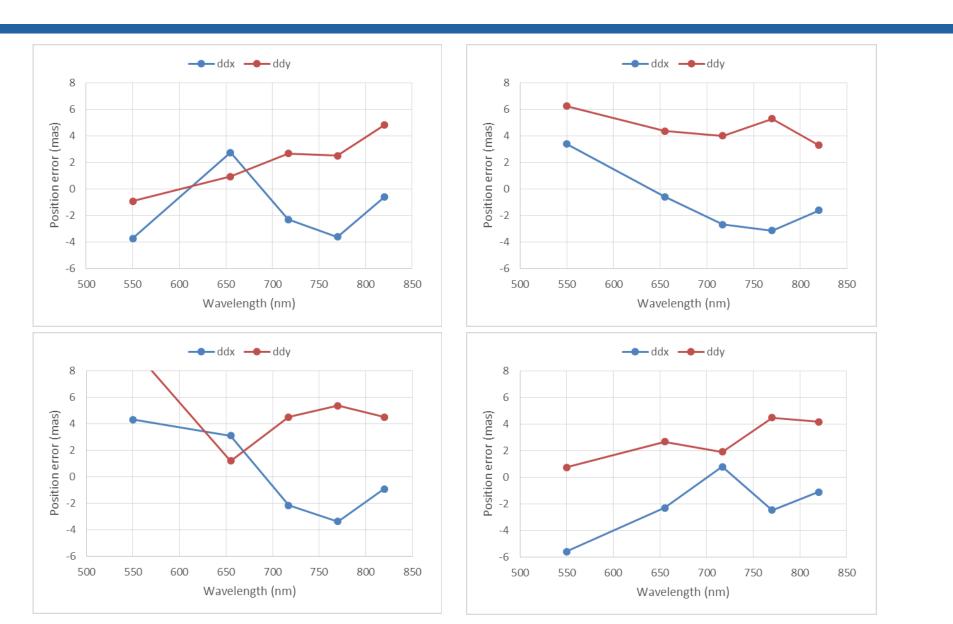
Comparison of contrast curve for 3 different stars with similar H-band magnitude (~ 7.3 AB) at 3 different airmass. Contrast variation mostly due to weather conditions! No ADC effect detected.



The two epochs of HD113803 were taken under same seeing (0.96" at 0.65microns, but very different wind speed. Considering that the observations were taken at aimass~1, the difference here is therefore due to the wind speed.

The two epochs of HD122652were taken under same seeing (~1" at 0.65microns) and same wind speed (~8.3m/s). The observations were taken at aimass~1.8, the difference here is therefore mostly due to the ADC.

ADC Performance - ZIMPOL



DISCUSSION

IFS: Global spec proven to z~55deg

Current data image analysis does not provide sufficient astrometric accuracy to verify sub-mas inter-band specs

IRDIS: Next step: Complete the study of the ADC performance with the analysis of IRDIS Long-Slit Spectroscopic data.

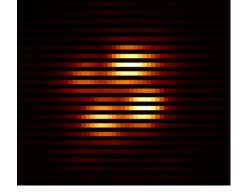
ZIMPOL: Residual dispersion estimated to 5-10mas from 550nm to 820nm at 51 deg from Zenith Spec is 9.8nm for VBB band

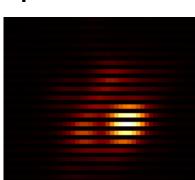
Several difficulties encountered:

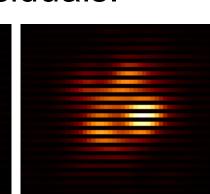
- Image shift due to prismatic filters
- Temporal evolution of dispersion during the measurements
- ADC stability after change of derotator position
- Low-wind effect (LWE, also known as the Mickey effect): NIR PSF anomaly observed on similar instrument at other observatories.

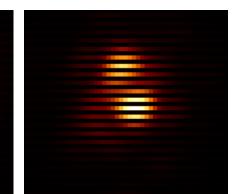
Observation method developed to allow fine, mas-level ADC characterization using simultaneous observations in the two ZIMPOL channels.

Results from Comm4 hampered by the Mickey effect. Temporal and spectral variations in the psf shape due to the constantly evolving LWE were of the same order as the expected dispersion residuals.









CONCLUSIONS

IADC: Could gain performance at very high z Within spec for wide-band performance up to z~55deg

In-band performance is expected to be within spec since no high-frequency spectral signatures can be present *VADC*: New measurements required for more precise characterization

Current adjustment of ADC parameters is not bad Within spec at z=51deg

More studies are required if further fine tuning of ADC parameters is deemed necessary

REFERENCES

- 1. Bertin et al, 1996, A&AS, 117, 393B
- 2. Beuzit et al., 2008, SPIE, 7014E, 18B
- 3. Pavlov et al., 2008 SPIE, 7019E, 39P
- 4. Vigan et al., 2015, MNRAS, 454, 129
- 5. SPHERE User Manual, VLT-MAN-SPH-14690-0430_v97_2016-01-12.pdf
- 6. SPHERE Data Reduction Pipeline Manual: VLT-TRE-SPH-14690-660.pdf

















