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First Fringes with ANTU and MELIPAL

A. GLINDEMANN, P. BALLESTER, B. BAUVIR, E. BUGUEÑO, M. CANTZLER, S. CORREIA, F. DELPLANCKE, F. DERIE, P. DUHOUX, E. DI FOLCO, A. GENNAI, B. GILLI, P. GIORDANO, P. GITTON, S. GUISARD, N. HOUSEN, A. HUXLEY, P. KERVELLA, M. KIEKEBUSCH, B. KOEHLER, S. LÉVÊQUE, A. LONGINOTTI, A. LOPEZ, S. MÉNARDI, S. MOREL, F. PARESCE, T. PHAN DUC, A. RAMIREZ, A. RICHICHI, M. SCHÖLLER, J. SPYROMILIO, M. TARENGHI, A. WALLANDER, R. WILHELM, M. WITTKOWSKI

1. Introduction

On October 30, 2001 at about 1 a.m., the two 8-m Unit Telescopes ANTU and MELIPAL of Paranal Observatory were combined for the first time as a stellar interferometer observing fringes on the star Achernar (see Fig. 1), only seven months and twelve days after the VLTI produced the first fringes with two siderostats. This was the first time that the VLTI was operated as a truly Very Large Telescope Interferometer. The VLT project of designing, building, and operating the VLT observatory and combining the Unit Telescopes as an interferometer, a project that kept most of ESO and many in the ESO community busy for more than a decade, reached one of its most important milestones.

As a preparation for this achievement, the Coudé Optical Trains and the Relay Optics were integrated in the Unit Telescopes, the third Delay Line System (required for using MELIPAL) had its final tests in July, and the beam compressors were assembled in the Beam Combination Laboratory of the VLTI. A new version of the interferometer control software was installed providing the additional functionalities that are required to combine two UTs (see article on page 2). With the support of NEVEC[1], the data pipeline has matured considerably over the last six months, and it now produces results for the visibility, the transfer function and statistical parameters enabling on-line data quality control.

At the beginning of October, the CCD in the VINCI test instrument saw first light with the Unit Telescopes (see Fig. 2) showing an image quality that was well within specifications: the image size was limited only by the seeing of 0.45 arcsec. There was no indication that the 200-m light path and the 28 reflections between the primary 8-m mirror and the CCD affected the image quality.

[1]NEVEC is the NOVA (the Netherlands Research School for Astronomy) – ESO VLTI Expertise Centre at the Leiden Observatory.

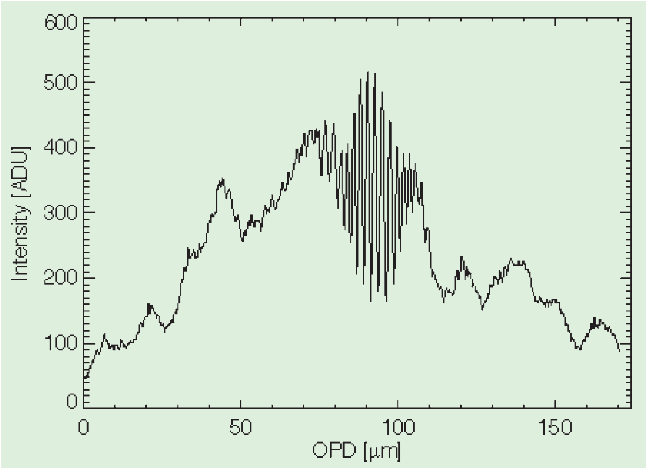

Figure 1: Raw interferometric fringes of Achernar in the K-band, as observed on the computer screen in the VLTI Control Room at the moment of First Fringes.

2. First Fringes

The night of October 29/30 started with tests of the Coudé Optical Trains and the Relay Optics, converting the light from the Coudé focus to a parallel beam in the Delay Line Tunnel. For the history books it should be noted that one of these mirrors (M9) arrived only on the very same night at Paranal, and a small dummy mirror with a diameter of 40 mm – albeit of very good optical quality – on a temporary mount had to be used for First Fringes.

Around midnight, when the UT team finished the tests and the search for fringes could start, not everybody on the mountain would have bet how quickly the search was successful. Before actually seeing fringes with a new baseline, a number of assumptions has to be taken on the internal path lengths in each arm of the interferometer and on the distance between the telescopes. When distances between individual mirrors can be measured with very high precision (some 10 microns), the distance between the telescopes, i.e. the baseline, is only known with a precision of some 10 millimetres. These uncertainties can be corrected after fringes are found on different stars, and the so-called OPD (Optical Path Difference) model of the interferometer is refined. Depending on the discrepancy between the assumed baseline and the real baseline, the first search for fringes can take several hours since the scan for OPD zero position where fringes can be found has to be done at speeds of about 1 mm per minute.

However, barely one hour after we had started, the automatic fringe search routine in VINCI reported 'flecos en el cielo', and the fringes appeared on the screen. We found that the baseline of 102.5 m between ANTU and MELIPAL differed by only 28 mm from their nominal length. After refinement of the OPD model, fringes were subsequently found within 0.4 mm of their calculated position.

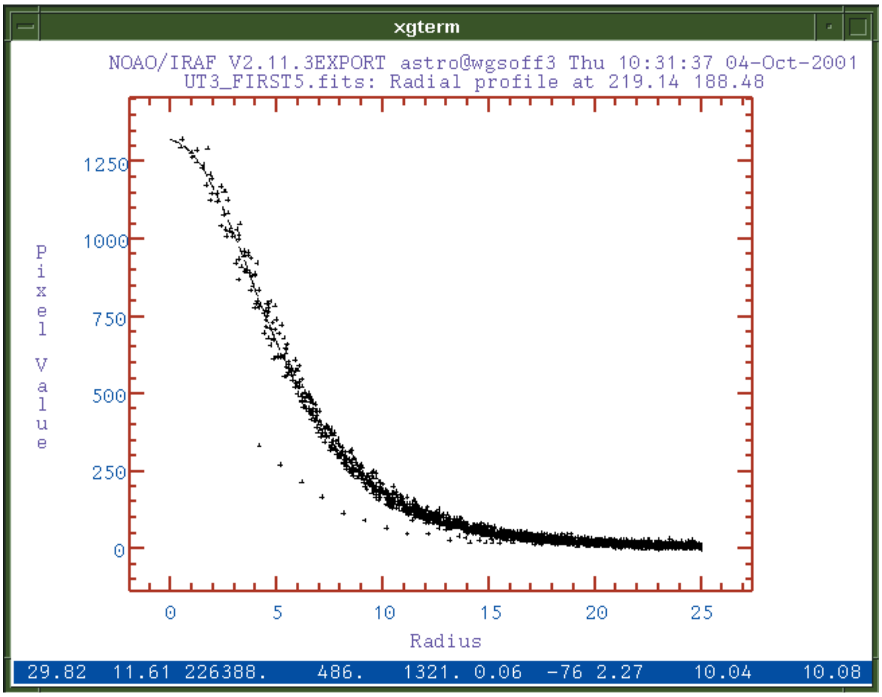

Figure 2: The radial plot of the first stellar image on a CCD at the VLTI focus collected with the 8-m telescopes. After 28 reflections and 200 m of optical path inside the VLTI, the image size of 0.45 arcsec was limited only by the seeing.

With the experience that we had gathered over the last six months of commissioning, 'routine operation' with the 8-m telescopes started almost immediately with a number of scientific observations: the first measurements of the diameter of red dwarfs (Kapteyns star, HD 217987 and HD36395), the precise determination of the diameter of Cepheids (Beta Dor and Zeta Gem), the so-called light houses of the universe, and the first measurement of the core of Eta Carinae (for details see the press release). A total of 17 different stars was observed during this observing run. The technical downtime was less than two hours per night.

The faintest star that could be observed had a magnitude of K = 6.3, and this is all the more remarkable as the 8-m telescopes were used without any adaptive optics correction. The star light in VINCI has to be fed into an optical fibre with a diameter of 6.5 microns which is the diameter of the diffraction limited Airy disk and, thus, a perfect match if the telescopes produced diffraction limited images. Without adaptive optics, this optical fibre is merely fishing for photons in the middle of the speckle cloud with a diameter of about 0.6 arcsec which is 10 times the diffraction limit. The number of photons entering the fibre is then about 100 times or 5 stellar magnitudes smaller than what could be expected with adaptive optics.

We are now looking forward to improving the performance for the following UT observing runs by implementing the tip-tilt correction in the Coudé foci and by tuning the infrared camera read-out mode. The general planning for the following years is described in *The Messenger* No. 104, p. 2 (June 2001).

The VLTI Data Flow System: From Observation Preparation to Data Processing

P. BALLESTER[1], P. KERVELLA[1], L.P. RASMUSSEN[2], A. RICHICHI[1], C. SABET[1], M. SCHÖLLER[1], R. WILHELM[1], B. WISEMAN[1], M. WITTKOWSKI[1]

[1]European Southern Observatory, Garching, Germany
[2]ROVSING A/S, Skovlunde, Denmark

In this article we present the Data Flow System (DFS) for the VLT Interferometer (VLTI) that is analogous with that of other telescopes of the VLT. The DFS was first installed for VLTI first fringes utilising the siderostats together with the VINCI instrument and is constantly being upgraded in phase with the VLTI commissioning. A recent VLTI achievement has been the first fringes with the Unit Telescopes (see article on page 1). For this milestone the VLTI