

Application Report: Running μ ShapeTM on a VF-20 Interferometer

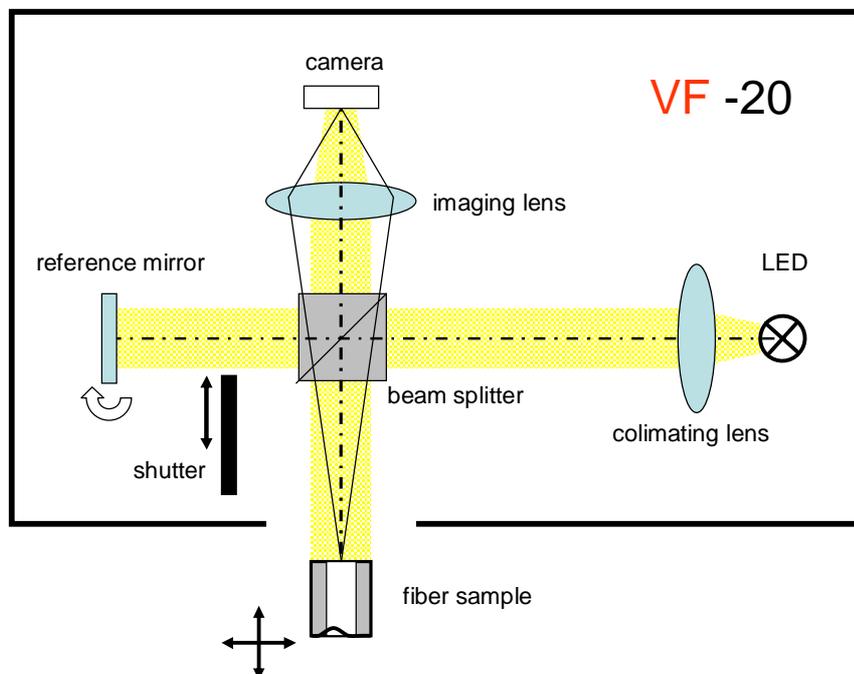
General

This report describes how a fiber interferometer from Arden Photonics Ltd was used together with the μ ShapeTM Generic software package. The VF-20 is a high magnification interferometer for inspecting optical fiber end quality on flat and angled ends. It is available for fibers up to 1mm in diameter. For the tests shown below some test fibers with 300 μ m diameter were used.

1 How VF-20 works

The optical setup of the VF-20 is a Twyman-Green interferometer. As light source a yellow LED is used. The two operation modes are realized by a mechanical switch mounted in the reference arm of the interferometer. In inspection mode the reference arm is blocked whereas in fringe mode it is open and interferences between the reference mirror and the fiber end can be seen.

The fiber samples are fixed in the test arm in front of the interferometer by v-grooves clamped with a magnetic strip.



Due to the short coherence length of the LED fringes can only be seen when reference and test arm have nearly the same (optical) length. For adjusting the fiber three translation stages (x,y,z) can be used. Tilt is not adjustable.

In order to use the interferometer without phase shifting a basic tilt has to be adjusted during the interferometer calibration by tilting the reference mirror when a perfect fiber cleave is set into the sample mount.

Depending on the current operation mode the detected image on the camera shows either the fiber end and allows to qualify its surface by visual inspection or it shows interference fringes for interferometric qualification.

2 Upgrading VF-20 with μ Shape™

2.1 μ Shape™

The μ Shape™ Generic software is a modular software package for driving two-beam interferometers for testing surfaces and wave fronts. Originally developed to support interferometers using phase shifting techniques it now also supports interferometers without phase shifting devices like the VF-20. In such cases the μ Shape™ FastFringe version is used.

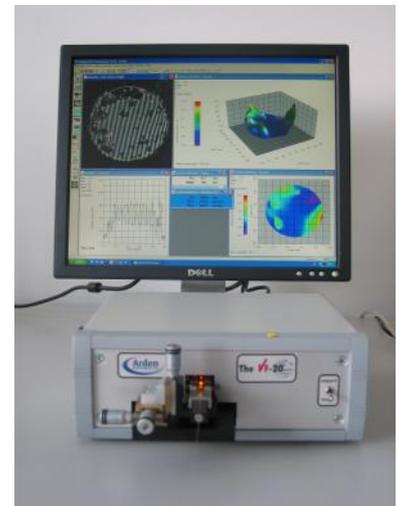
The μ Shape™ is split into three modules:

- Hardware interface module: controls the connected device
- Data acquisitions module: converts the primary detected measurement data into a phase map
- Analysis module: displays the phase map in different free-configured views and allows additional analyses like e.g. statistics (PV, RMS, etc.), ISO, polynomial representation (e.g. Zernike), slope analysis and much more.

All these modules are independent of each other and using well defined interfaces. So each part of the software can be easily adapted to specific tasks.

2.2 Driving VF-20 with μ Shape™

Due to the fact that VF-20 is a conventional Twyman-Green interferometer with an analogue video interface the standard μ Shape™ Generic package can be attached. No special hardware interface development was necessary. Immediately after installing μ Shape™ on a Windows® computer and connecting the video plug of the VF-20 with the Matrox CronosPlus frame grabber card in the PC the camera images from the VF-20 could be seen in μ Shape™.



2.3 Measurements

To demonstrate the opportunities of the μ Shape™ in combination with the fiber interferometer some measurements on the test fibers delivered with the system were done. The aim of these tests was to find out about the measurement possibilities. Therefore some assumptions were made which have to be adapted by the correct values when doing precise measurements.

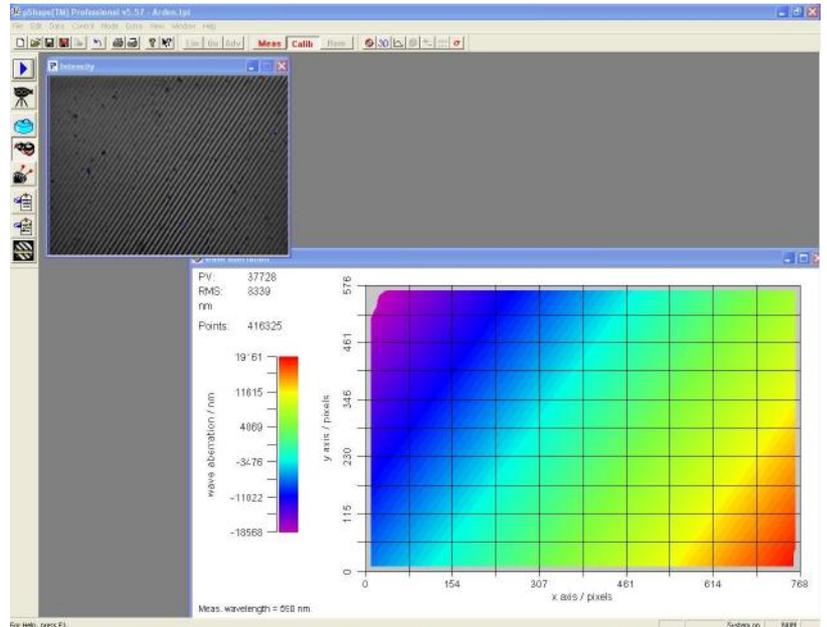
As measurement wavelength $\lambda=590\text{nm}$ (yellow) was chosen. In order to determine angle values a scaling value is needed. Using manual scaling we defined the lateral resolution of the interferometer assuming a diameter of $300\mu\text{m}$ for the visible fiber end.

For calibration of the system and adaption of the basic tilt of the reference beam a flat calibration normal with zero end angle was used.

In order to be able to apply the static fringe analysis methods a tilt of at least 10-20 fringes has to be introduced. That was done by tilting the reference mirror. So μ Shape™ was able to convert the fringe image into a phase map, respectively a surface topography map.

2.3.1 Calibration

The screenshot on the right shows the calibration measurement of our calibration surface. It is stored in the μ Shape™ and the results can be removed from the individual measurements taken in measurement mode. The calibration measurement has two functions: On the one hand it determines the system errors caused by the Twyman-Green setup, i.e. the optical path difference between both interferometer arms caused by possible optical elements in the individual interferometer arms. On the other hand it defines the reference angle for determining the cleave angle.

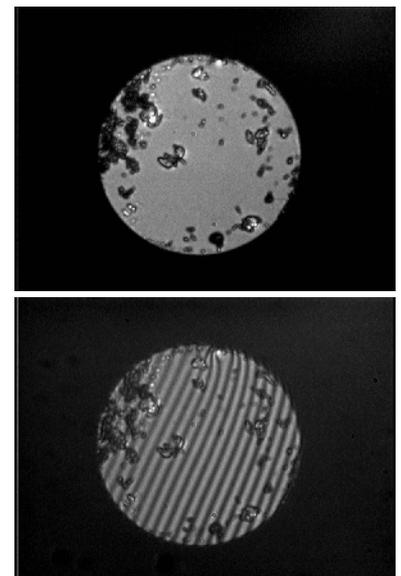


In the top left corner you see the interferogram of the calibration surface. The corresponding topography is displayed as false-color plot. The tilt is due to the fringes required for static fringe analysis.

2.3.2 Sample Measurements

After calibration a fiber was placed in the sample mount and adjusted as described by the VF-20 manual.

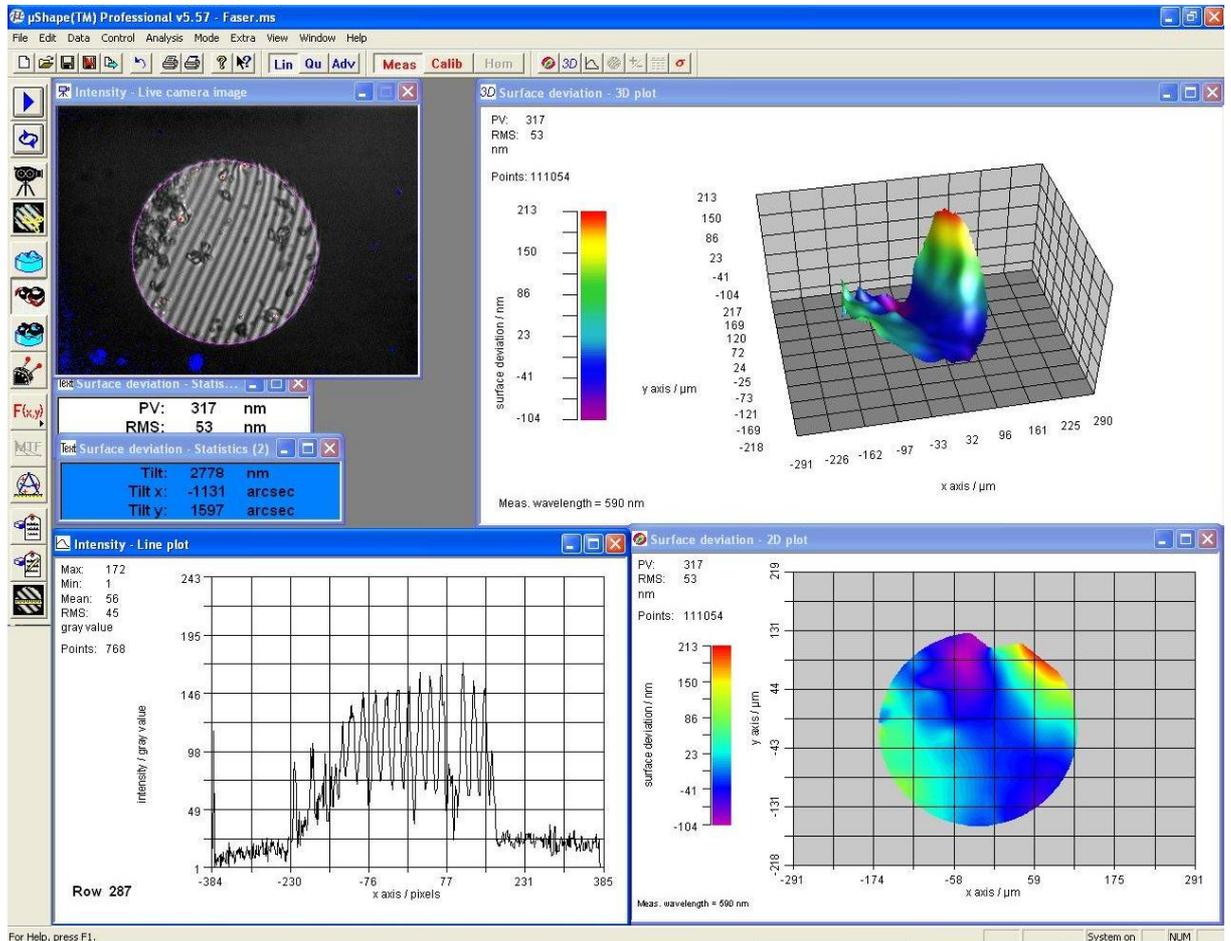
On the right you see the fiber end in inspection mode (top) and fringe mode (bottom). There are many defects visible on the surface. The fringe pattern shows fringes of different orientation and number compared with the fringe pattern in calibration mode. The reason here is that the fiber end surface has a different orientation and cleave angle than the calibration surface.



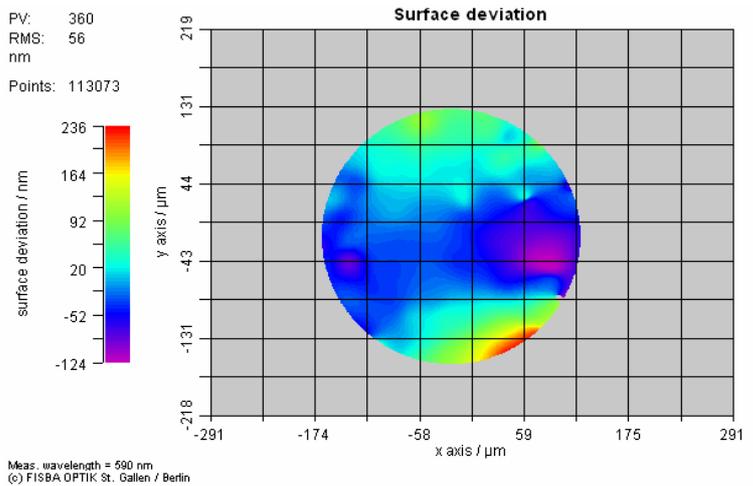
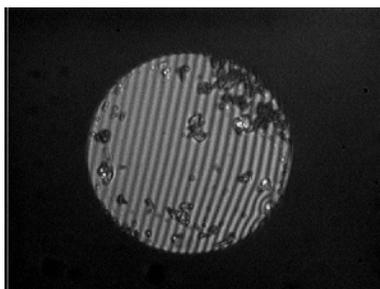
The screenshot below shows the measurement result of the fiber end surface taken in measurement mode. On the right the topography is shown as 3D and color plot. The calibration measurement is removed. So the topography shows the real shape error of the fiber end. The error refers to a mean flat surface fitted to the data map. The tilt of this fit reference related to the calibration is calculated by the alignment coefficients calculated during the fit. The result is given in the text box with blue background.

The Tilt value gives the absolute height value of the virtual wedge between the fit reference and the calibration flat. TiltX and TiltY are calculated by considering the lateral resolution of the setup (specified by the manual scaling). The other text box gives the PV (peak to valley) and the rms (root mean squares) value of the calculated surface deviation. The line plot below shows a cross section through the Intensity image.

We restricted ourselves to these analyses and presentations although there are several other views and analyses possible.



Rotating the fiber by about 90° gives following results.

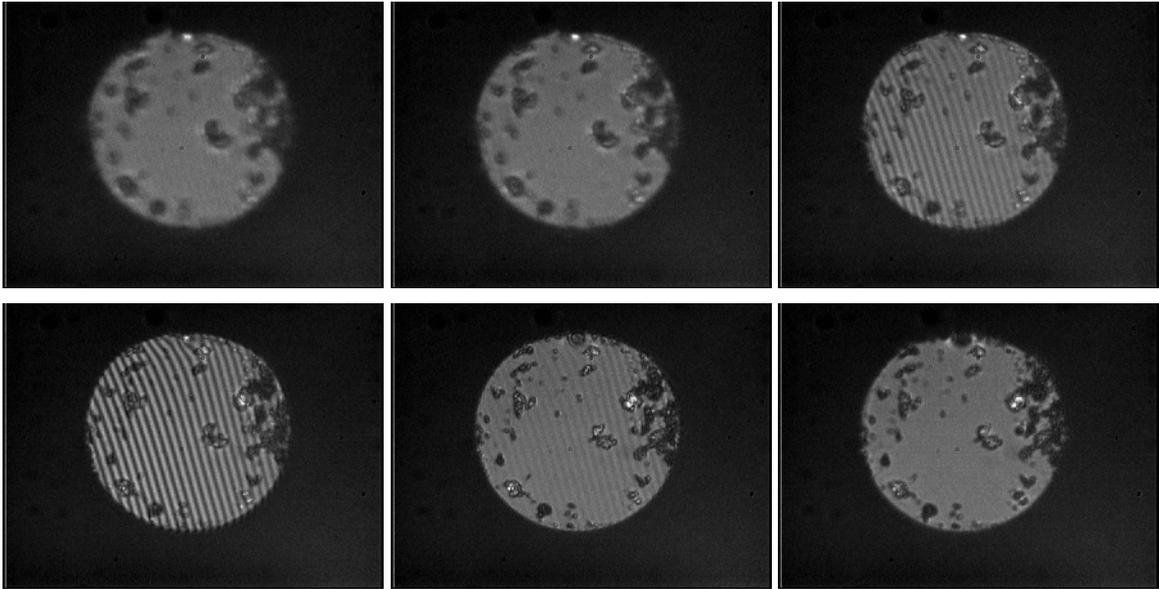


The Tilt results are:

Tilt: 2'908 nm
Tilt x: -267 arcsec
Tilt y: 2'060 arcsec

Both measurements agree well.

The following six images show how the fringe contrast changes when shifting the fiber about 5 microns along the z-axis.



The software calculates in all positions a phase map although only the 3rd- 5th images give comparable results.

3 Conclusion

It was demonstrated that it is easily possible to upgrade the VF-20 fiber interferometer with the μ Shape™ interferometry software package. This enables users not only to visual inspect their fiber end but also to measure the fiber cleaves by common interferometric methods.

Hardware modifications are not required although they are conceivable.