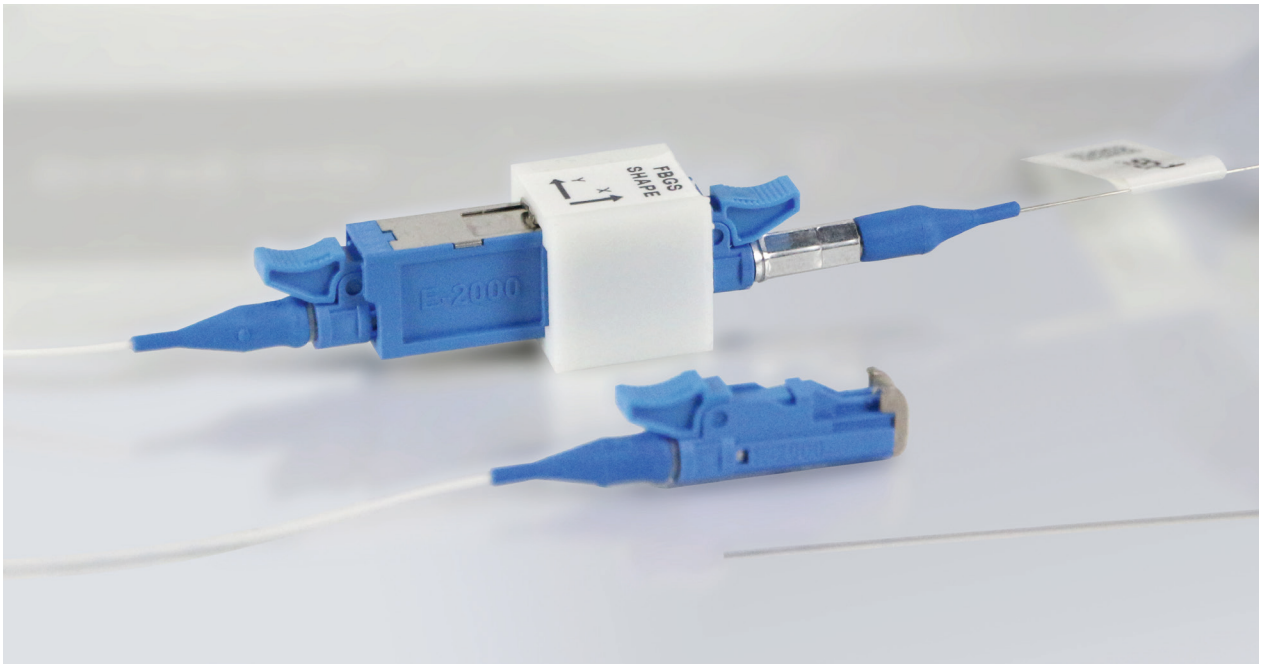
FBGS
Tailored Fiber Optic Sensing
Components & Solutions

White paper
FBGS ShapeProbe® accuracy



INFO

Draw Tower Gratings (DTG®s) are produced during the drawing process of the fiber itself, before the primary coating is applied.

This is a cost effective production process for high quality Fiber Bragg Gratings.
This offers unique characteristics such as extremely high breaking strength, insensitivity to bending, spliceless array configurations and uniform coating coverage. FBG parameters and coating material can be selected based on customer needs.

FBGS's shape sensing solution is based on the measurement of bending curvature and angle of the fiber at specific locations along the fiber. For example an A01 fiber has sensors located every 10 mm along its length, while an A02 has sensors every 20 mm. This distance is major factor for the quality of the reconstruction of the fiber shape, since the longer the distance between sensors, the more chances there are important features on the fiber shape are not detected.

This paper describes the influence of sensor distance on the quality of the shape reconstruction for four fibers with different sensor spacings: 10 mm, 20 mm, 30 mm and 40 mm (refs. A01, A02, A03 & A04)

For this assessment, the process consisted of inserting the tested fiber inside two different 3D printed shapes of veins (both 530 mm long), based on MRI data. The fibers were pushed into different random positions and rotated inside the shapes. For each fiber and vein shape, the measured fiber shape for 16 position and angle combinations was recorded. A matching and registration algorithm was then applied to match the measured shape to the known vein shape. Based on this match, the point by point error between the fiber and the vein shapes was computed.

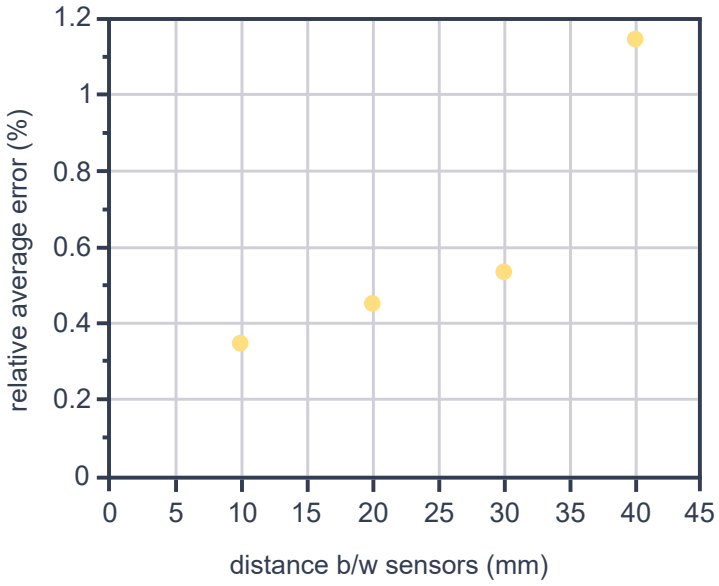
Assessment results

The table below summarizes the results:

Reference	A01	A02	A03	A04
Distance between sensors	10 mm	20 mm	30 mm	40 mm
Sensor length	250 mm	500 mm	750 mm	1 000 mm
Average error with reference shape	0.87 mm	2.25 mm	2.66 mm	5.73 mm
Average max. error with reference shape	2.47 mm	8.28 mm	10.20 mm	21.44 mm
Relative average error with reference shape	0.348 %	0.451 %	0.503 %	1.08 %

Given that the sensing length of the fibers is different, a way to estimate the accuracy is to divide the average error with the reference shape by the length used for registration.

These values are shown in the following graph.



Relative average error of the measured sensing length.

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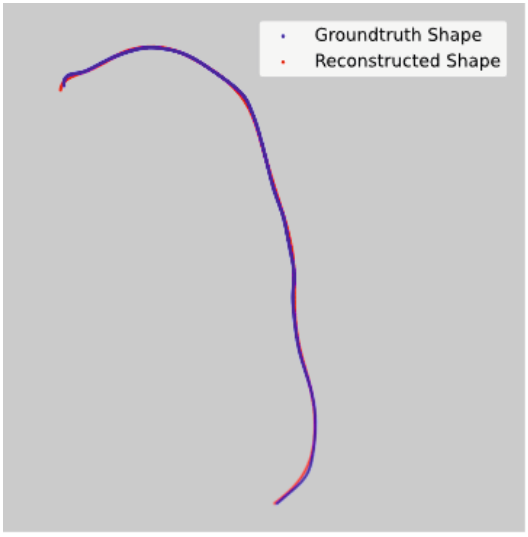
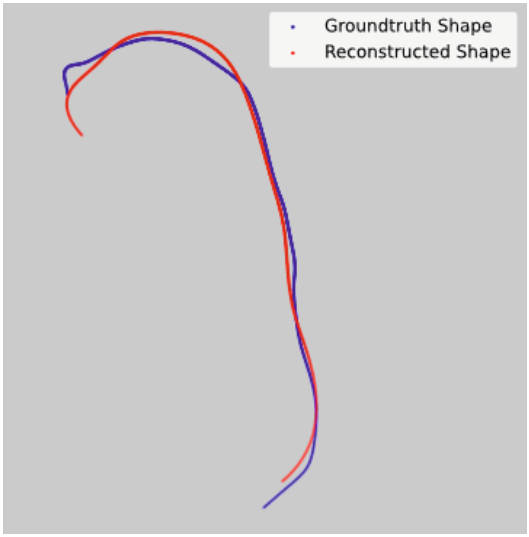
Assessment results

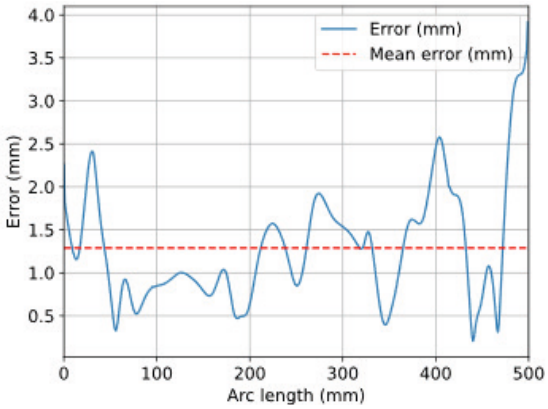
The following figures give examples of shape reconstruction for two different distances between sensors: on the left 20 mm, and on the right 40 mm.



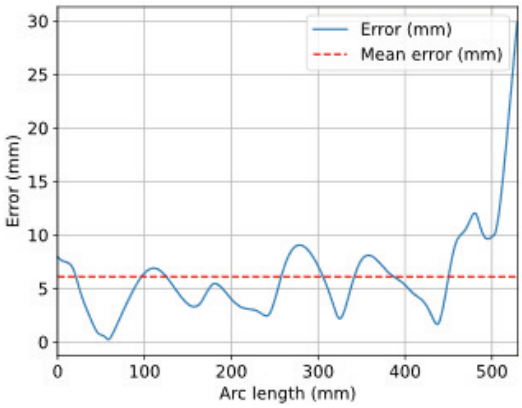
3D visualization of the reference and reconstructed shapes for an acquisition with the A02 fiber.



3D visualization of the reference and reconstructed shapes for an acquisition with the A04 fiber.



Error as a function of arc length for an acquisition with the A02 fiber.



Error as a function of arc length for an acquisition with the A04 fiber.

INFO

As stated before, the accuracy of the reconstruction depends highly on distance between the sensors. With the current fitting method, the error is generally higher at either one or both ends of the shapes due to error accumulation.

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