# ANISOTROPIC OPTICAL FIBER IN DISTRIBUTED ACOUSTIC SENSING

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## Abstract

This work presents one of the ways to use anisotropic optical fiber as a sensing element in distributed acoustic sensing. Unique features of the created setup are based on the ability the probe the sensing element with a pulse of ligth from both of its sides in opposite directions and polarization axes continuously, without the reconnection or movement of the interrogator. A hypothesis under investigation was the opportunity to enhance the resolution of the multiple close events on the fiber with the proposed sensing element construction. Initial tests have been carried out under static events, e.g. inducted losses. Though the method is theoretically not limited by this type of anisotropic optical fiber, the present research includes the data obtained only with the "Panda" fiber. We believe the setup can be a more comfortable analog to the two-way trace analysis in a bunch of distributed acoustic sensors' applications. Higher losses of anisotropic fiber, comparing to the SMF-28, for example and higher price of the whole setup turn out to be its main disadvantages. Despite the fact that current report is based on the setup interaction with optical time-domain reflectometer, the crucial aim of the research is its application in coherent distributed optical sensing system, like the one for agriculture and biological purposes proposed before.

## Keywords

Rayleigh backscattering, acoustic vibrations, DAS, anisotropic optical fiber

## INTRODUCTON

In OTDR [1] technology, the problem of event dead zones can be solved with the help of two-way trace analysis. After all, it can be seen, the dead zone is located mainly behind the event, therefore, if a pulse is injected into the fiber from the opposite side, then the dead zone on such a reflectogram will be opposite. But in order to realize the advantages of two-way analysis of traces, it is necessary to have access to both ends of the fiber under study, which is far from always possible or convenient, especially, for example, if the fiber communication line or fiber optic sensing element has already been mounted or installed inappropriately.

## SETUP CONSTRUCTION

To solve the problem of dead zones and access to the two ends of the fiber, mainly in the design of the proposed distributed acoustic sensor, it is proposed to refine its design in terms of the sensing element. So, instead of a standard single-mode fiber, it is supposed to use an anisotropic optical fiber of the "Panda" type, which provides a sufficiently independent propagation of 2 polarization modes [2], a fiber polarizer and a polarization beam splitter (Fig. 1).

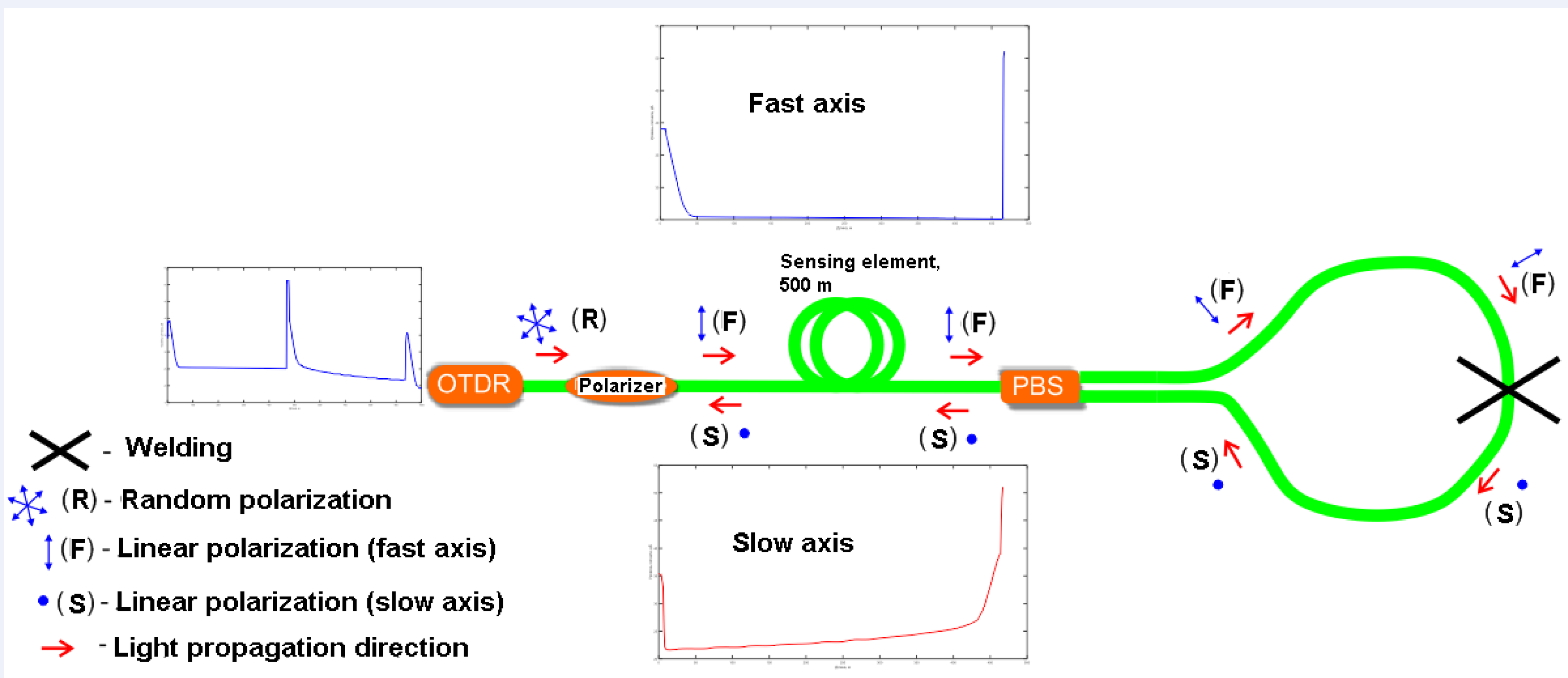


Figure 1: Suggested improvements to the distributed acoustic sensor.

## HYPOTHESIS AND RESULTS OF INVESTIGATION

In addition to trying to solve the problem of the event dead zones, it was decided to test the hypothesis that the configuration of the sensing element used can better distinguish between closely spaced events [3] (Fig. 2).

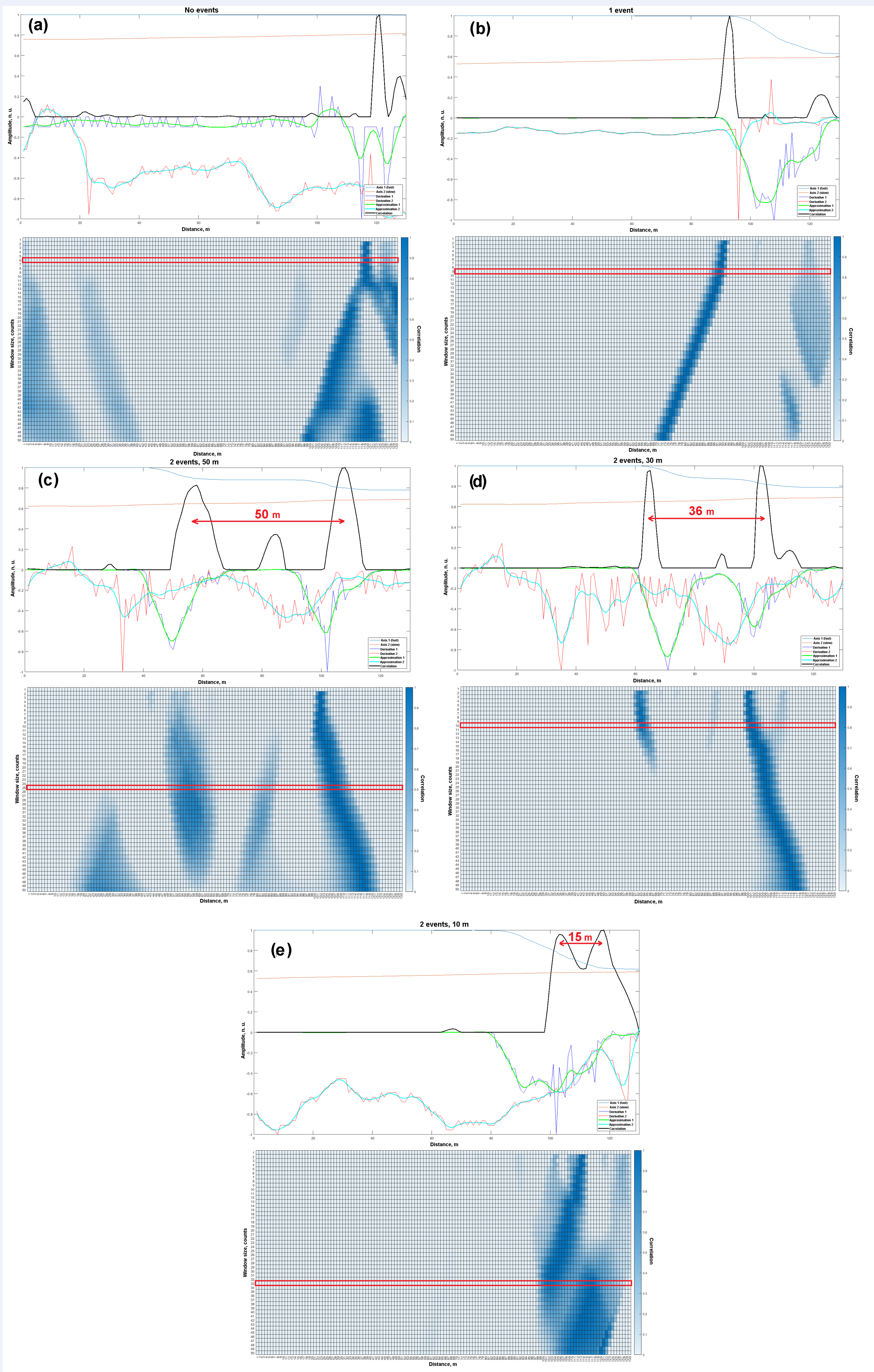


Figure 2: Heat maps and reflectograms with derivatives, approximations and correlation coefficients. (a) – without impacts; (b) - 1 impact; (c) - 2 impacts with a gap of 50 m, (d) - with a gap of 30 m, (e) - with a gap of 10 m. The area corresponding to the value of the window for which the sections were plotted is highlighted in red on the heat map.

## References

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