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# Numerical model for radial symmetric sensors for partial discharge detection on XLPE-insulated high voltage cables

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**Résumé**
Un modèle théorique d'un détecteur radial symétrique de décharges partielles pour câbles PR haute tension a été développé. Les caractéristiques du détecteur ont été déterminées par le calcul d'une solution numérique et par l'expérimentation. Les résultats obtenus par le logiciel de calcul sont discutés et comparés avec ceux de l'expérimentation

**Abstract**
A theoretical model of a sensor for partial discharge (PD) detection on XLPE-insulated high voltage cables resp. joints has been developed. The model handles radial symmetric sensors. The dependence of sensitivity on geometrical characteristics of the sensor is investigated theoretically as well as experimentally. The results of computer simulation are discussed and compared with experimental data of such sensors.

## Introduction

Sensitive partial discharge (PD) detection is a very important test to ensure the reliability of high voltage (HV) and extremely high voltage (EHV) cable systems with extruded polymeric insulation. However, the conventional PD detection method with decoupling of PD pulses at the cable end is not suitable for long cable lengths because of the limited sensitivity due to the strong high frequency attenuation of high voltage cables. Therefore it is necessary to detect PD close to their possible source, e.g. at joints or terminations, which are mounted on-site.

A common PD detection method is based on the coupling of PD pulses into sensitive field sensors [1-4], which are usually placed directly at or inside the cable accessory. However, noise coupled from outside into the cable may be much stronger than the fields generated by partial discharge. This limits the sensitivity of a measurement to a level which is often unsatisfactory.

In order to design and to improve radial symmetric field sensors, e.g. capacitive or mixed inductive-capacitive sensors, like the directional coupler sensor, a finite-difference time-domain (FDTD) model of the XLPE cable and the symmetric sensor has been developed [5]. This model is described in details in the section one. Computations done according to this model are presented in the section two. Comparison with measurements showed that even the simple model, which is not taking into account dispersive characteristics of the cable, can be used to predict the dependence of the sensor sensitivity on important parameters of the problem.

## 1 Theory

In this section we describe a finite-difference time-domain (FDTD) model of a XLPE cable and a radial symmetric field sensor, shown in Fig.1.

The model consists of 2 parts, the electrodynamical description of the high voltage cable with the inner conductor, insulation, inner and outer semicon layers and outer shield and the electrodynamical description of the partial discharge sensor. The sensor is placed on the outer semicon layer and consists of an insulation layer, the electrode and a dielectric substrate above the electrode. The sensor is completely covered by the outer shield of the cable (metallic sheath or foil) and thus shielded against external noise.