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Abstract 47847

Direct RF magnetic field conversion by electro-optic effect for MR endoluminal coil

Type: Scientific Session Communications

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Purpose/Introduction

The benefit of MR endoluminal coil was demonstrated for imaging of internal tissue layers such as colon walls [1]. However, since metallic coaxial cables are used, heating phenomena may occur in neighbored biological tissues due to local electric field concentration [2]. Optical fiber link for MR signal transmission could be used to overcome local heating, thus ensuring patient safety. In this work, the use of electro-optic effect occurring in a LiTaO₃ crystal associated to a single loop endoluminal coil to perform a local electro-optic conversion was demonstrated and characterized.

Subjects and Methods

The conversion of the Radio-Frequency (RF) magnetic field into an electric signal by electro-optic (EO) effect was validated with, an experience showed on Fig. 1. RF magnetic field B_x at 127 MHz was generated using an emission RF surface coil with a function generator. The electrical power P_{in} of the generator varying from 14 dBm down to -60 dBm.

The endoluminal coil shown in Fig. 2, tuned to a frequency of 127 MHz, was placed to probe the magnetic field B_x . Thus an electromotive force ε was induced onto the z-axis of the crystal thanks to copper deposited electrodes.

A linear polarized optical probe beam passes through the EO crystal, whose eigen refractive indices change due to ε . Hence, a modulation of the laser polarization state appears. A quarter wave plate and a polarizer convert this modulation into a modulation of optical power. Finally, this latter is converted into an electrical signal using a photodiode. A spectrum analyzer state the output signal power P_{out} [3].

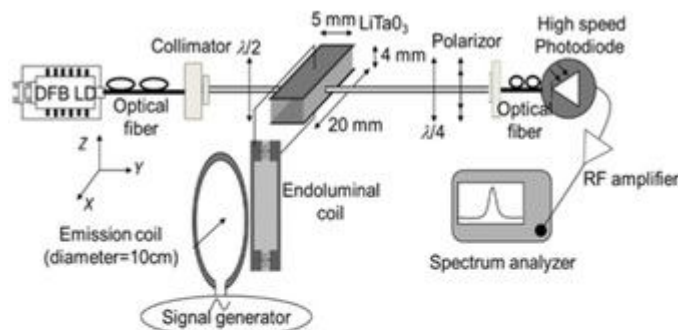


Fig.1: Schematic set up of the experiment for the EO conversion of the RF magnetic field for an endoluminal coil.

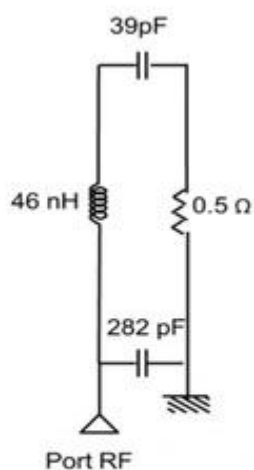


Fig.2: Circuit of the endoluminal coil tuned to a frequency of 127 MHz and matched to 50 Ohms

Results

The sensibility and the linearity of the EO conversion are shown in Fig. 3. The measured values fit closely to the expected values and the dynamic exceeds 60 dB which is down limited by the noise floor. The minimum detectable magnetic field is 176 ± 4 pT.

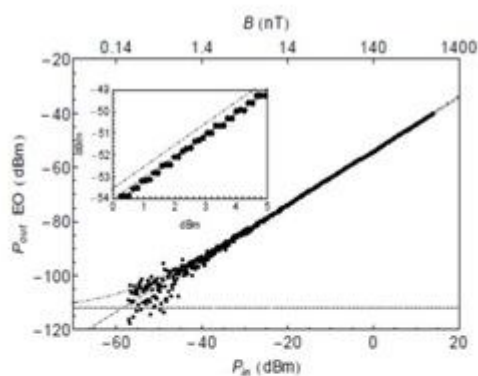


Fig.3: EO response as a function of the input power feeding the transmit coil and the correspond magnetic field (top axis). Black dots are the measurement points and dashed dotted line is the theoretical curve.

Discussion/Conclusion

The EO signal conversion using a LiTaO₃ crystal with an endoluminal RF coil was demonstrated using an experimental bench of measure. The sensibility of the conversion could still be improved. The next step will be to build an endoluminal coil with active optical decoupling to perform first phantom experiments.

References

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- [2] C. Armenean et al., *Magn. Reson. Med.*, 2004, Vol.52, 5, pp. 1200-1206.
- [3] R. Ayde et al., *IEEE sensors journal*, 2013, Vol.13, pp. 1274-1280.

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