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HOMOGENEOUS AND HIGH GRADIENT STATIC MAGNETIC FIELDS GENERATION

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Abstract: In the first part of the paper, a generation of homogeneous static magnetic fields by using modern permanent magnets and soft magnetic materials is discussed. The second part deals with high gradient magnetic fields generated by special permanent magnets configuration. Finally, there is a comparison of the both groups' results.

Keywords: Static magnetic fields, homogeneous magnetic field, high gradient magnetic field, permanent magnets

1. Introduction

In practice, there are two types of contradictory static magnetic fields. The first type represents high homogeneity static magnetic fields in a large area. This field can be realised within an unlimited period by special (Watson) circuit without energy demands. The Watson circuit can be used in applications, where is a demand of a homogeneous static magnetic field realisation.

The second type is static high gradient magnetic field. This magnetic field can be realised by a simple quadrupole or a multiple quadrupole.

Permanent magnets based on rare earth, namely NdFeB, are the most frequently used in both applications.

2. Realisation of homogeneous static magnetic fields

The need of homogeneous static magnetic fields generation at bigger volume led to the magnetic circuit, called sometimes a Watson circuit. Two the same columns of permanent magnets, which have .been magnetised in the same

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direction, form this circuit. The columns are connected by two the same permeable sheets. Between the sheets, homogeneous magnetic field is realised. Homogeneity of generated magnetic field depends on a set of parameters, which may include a size and a distance of the sheets, a material of the sheets, e.g. The magnetic flux density value in the air gap depends mainly on material and dimensions of permanent magnets. In Fig. 1, there are presented results of realised circuit – permeable sheets 150x40x10 mm Fe, permanent magnets NdFeB 10x10x39 mm: a) Watson circuit and the map of magnetic flux density areas b) magnetic flux density curve in the middle of the air gap - from permanent magnet on the left side to permanent magnet on the right side (dot and-dashed line represents result of FEMM) c) magnetic flux density curve in the neutral cross-section

3. Realisation of high gradient static magnetic fields

Magnetic flux density distribution has been analysed in the area of high gradient magnetic fields generation in the simple, modified and double quadrupole. The analysis has been done by computation using the method of finite elements (the programme FEMM). Some of the configurations has been practically realised and measured, too. NdFeB permanent magnets with coercivity 880 kA/m has been used in realised models. In Fig. 2 there are presented: a) quadrupole configuration b) quadrupole magnetic flux density distribution with put in line A-A' c) calculated magnetic flux density curve in cross section A-A' d) measured magnetic flux density curve in cross section A-A'

4. Conclusion

In summary, there has been presented some theoretical and practical results of homogeneous and high gradient magnetic fields realisation. At the conference, some other results and their discussion will be presented.

References

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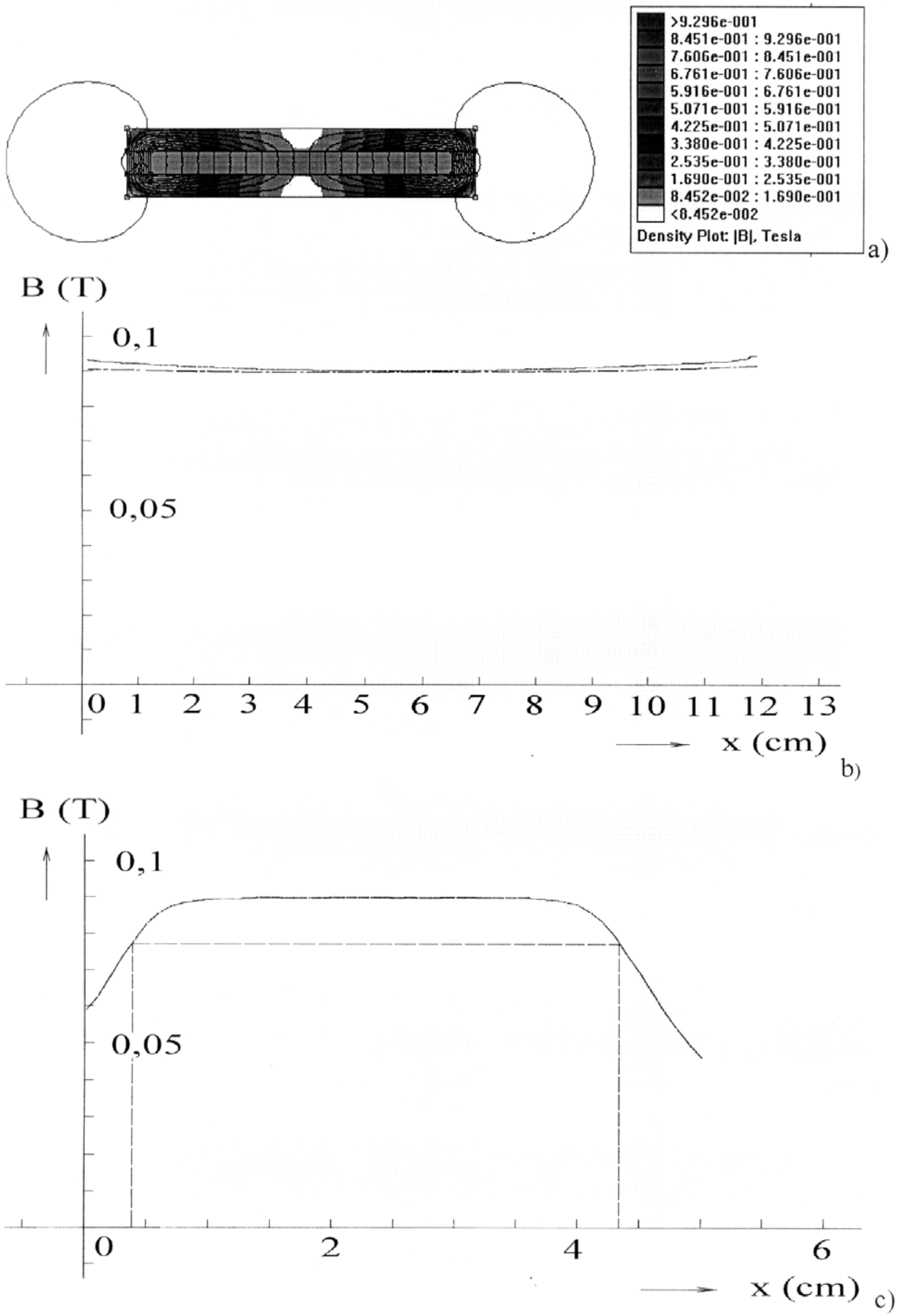

Fig. 1 Watson circuit (explanation in text)

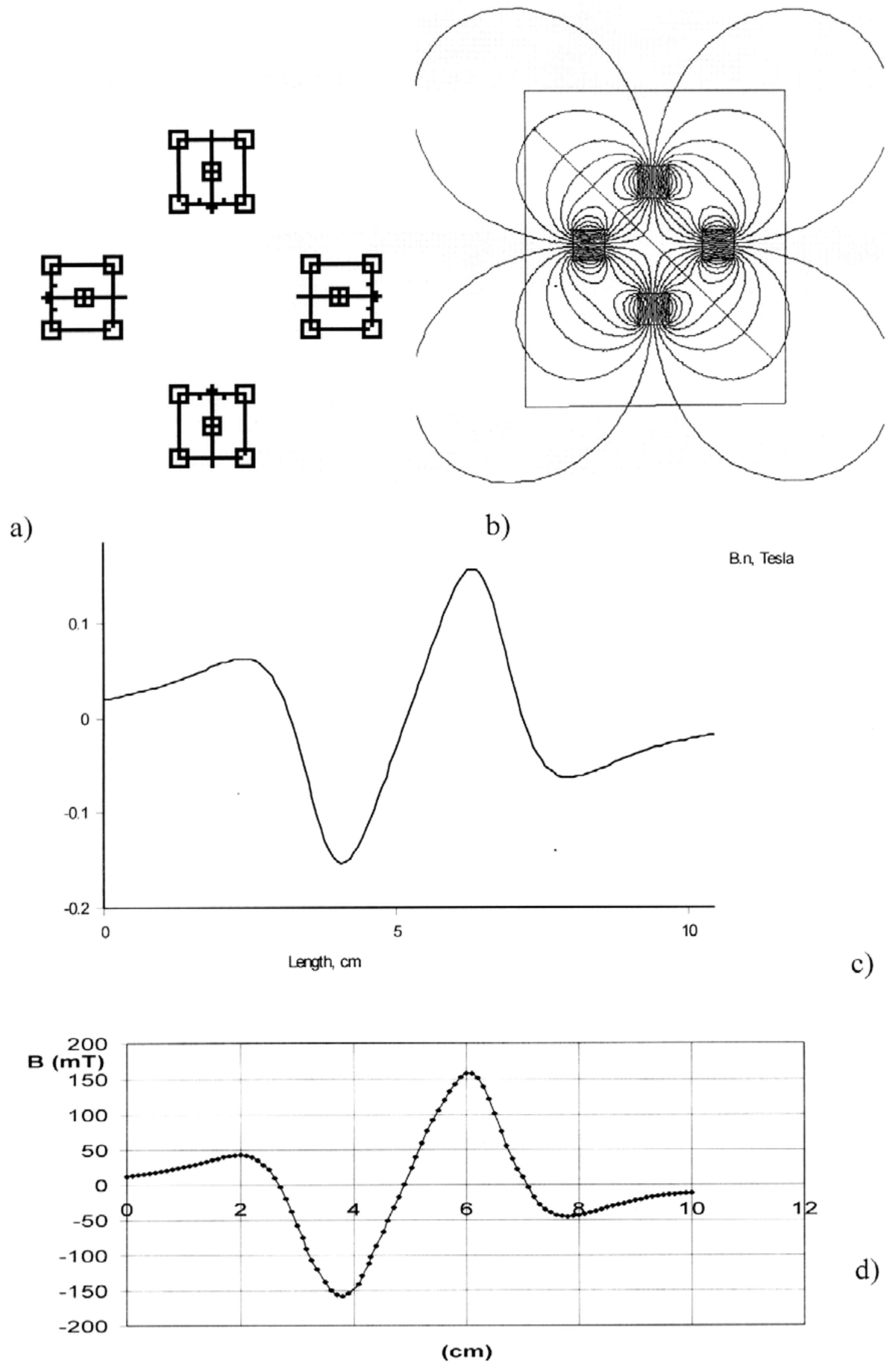

Fig. 2 Quadrupole (explanation in text)