Magnetic Devices For a Beam Energy Recovery THz Free Electron Laser

R. R. S. Caetano[1], G. Cernicchiaro[2], R. M. O. Galvão[3].
1. Universidade Federal do Rio de Janeiro, Macaé, RJ, Brazil, rcaetano@macae.ufrj.br
2. Coordenação de Física Aplicada, Centro Brasileiro de Pesquisas Físicas, Rio de Janeiro, RJ, Brazil, geraldo@cbpf.br
3. Instituto de Física USP, São Paulo, SP, Brazil.

CBPF
Centro Brasileiro de Pesquisas Físicas

Introduction: Free Electron Laser THz are an important source of coherent radiation being used in the study of chemical properties of substances, thus being an important tool for various fields of science such as condensed matter physics, chemistry, biology and medicine. This paper presents a numerical analysis of magnetic devices, dipole, quadrupole and undulator THz Free Electron Laser (FEL) electron-beam recovery system.

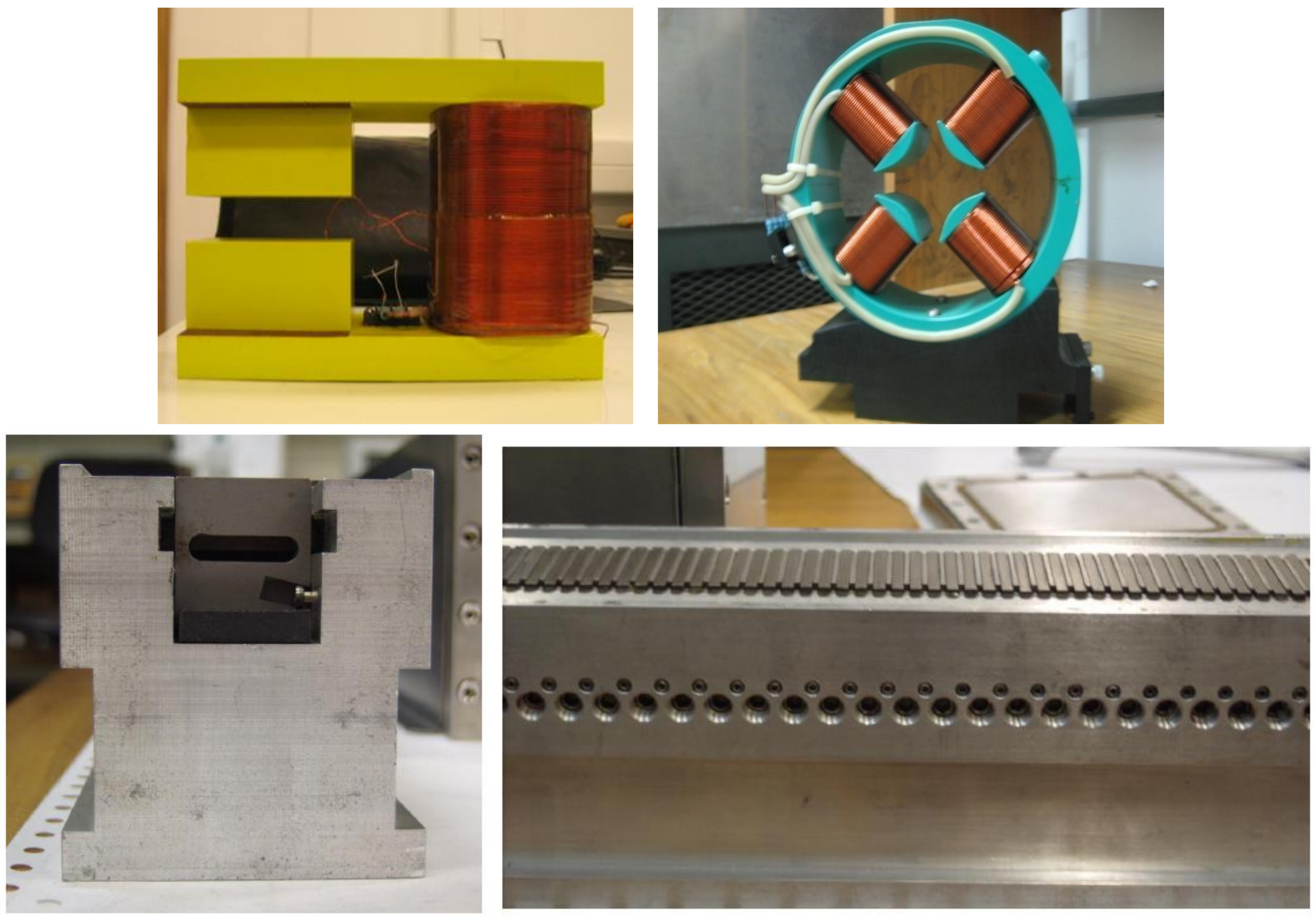

Figure 1. Dipole, quadrupole and undulator magnetic devices.

Computational Methods: The models presented in this paper are the dipole, the quadrupole and the undulator. For all components the *AC / DC Module* was used. For the dipole and quadrupole *Magnetic Fields* physics interface was used and for the undulator the *Magnetic Fields, No current* was used.

$$\nabla \times B = \mu_0 J_e$$

$$B = \nabla \times A$$

Equations used in dipole and quadrupole magnetic.

$$\vec{\nabla}.\,(\mu_0 \vec{\nabla} V_m - \mu_0 M) = 0$$

The equation used in magnetic undulator.

Results:

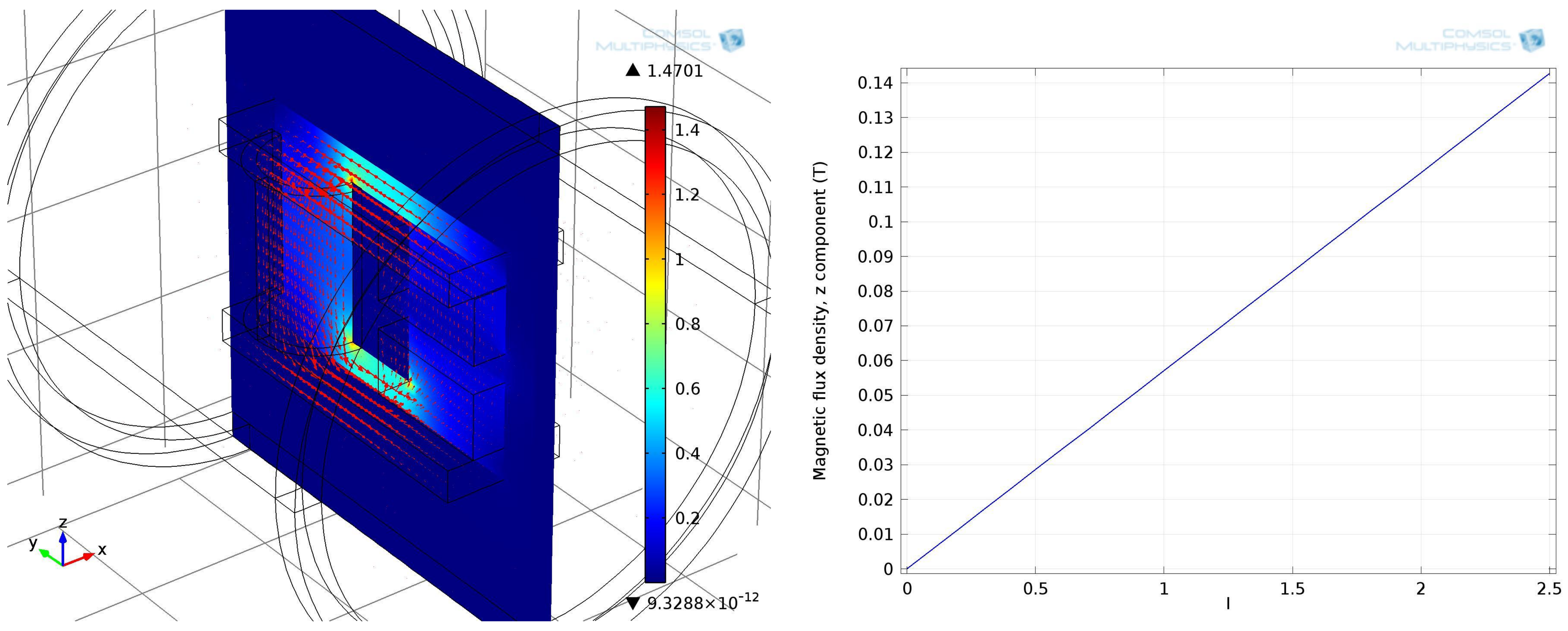

Figure 3. Magnetic Flux density and Graph magnetic field x current electric in dipole.

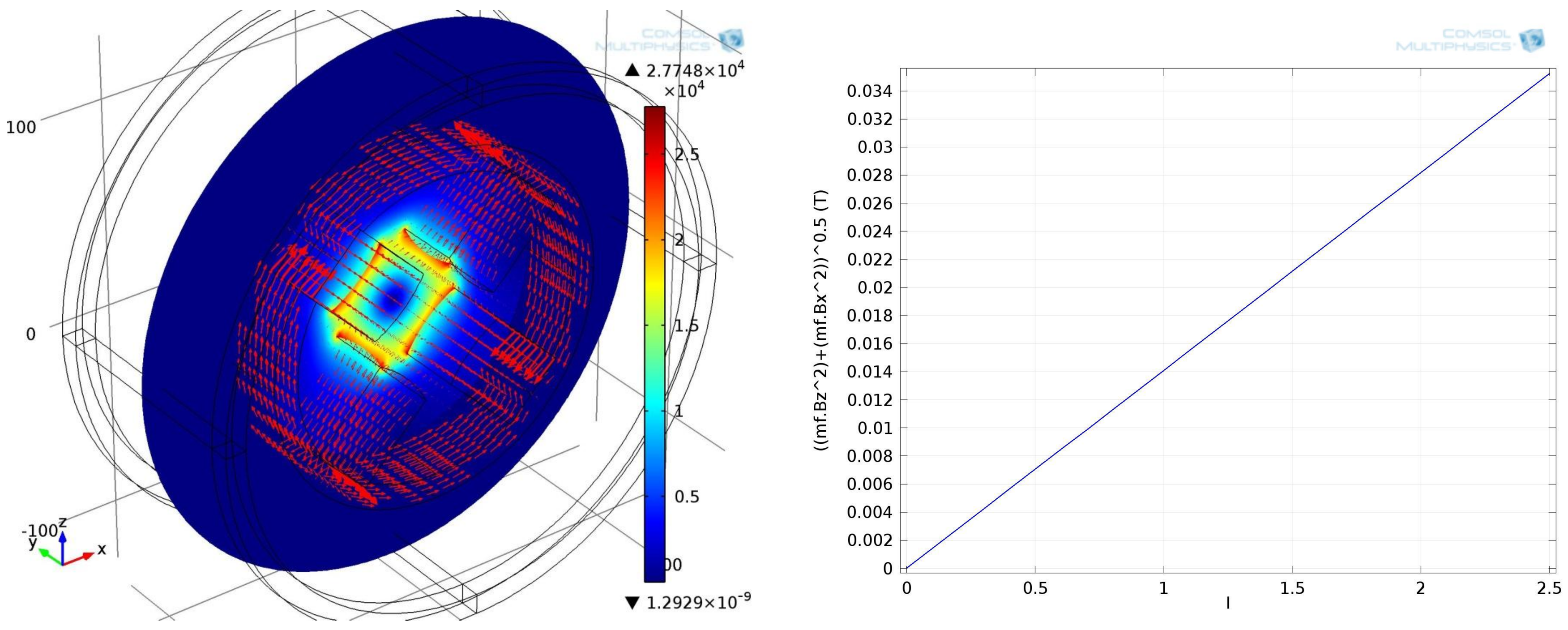

Figure 4. Magnetic Flux density and Graph magnetic field x current electric in quadrupole.

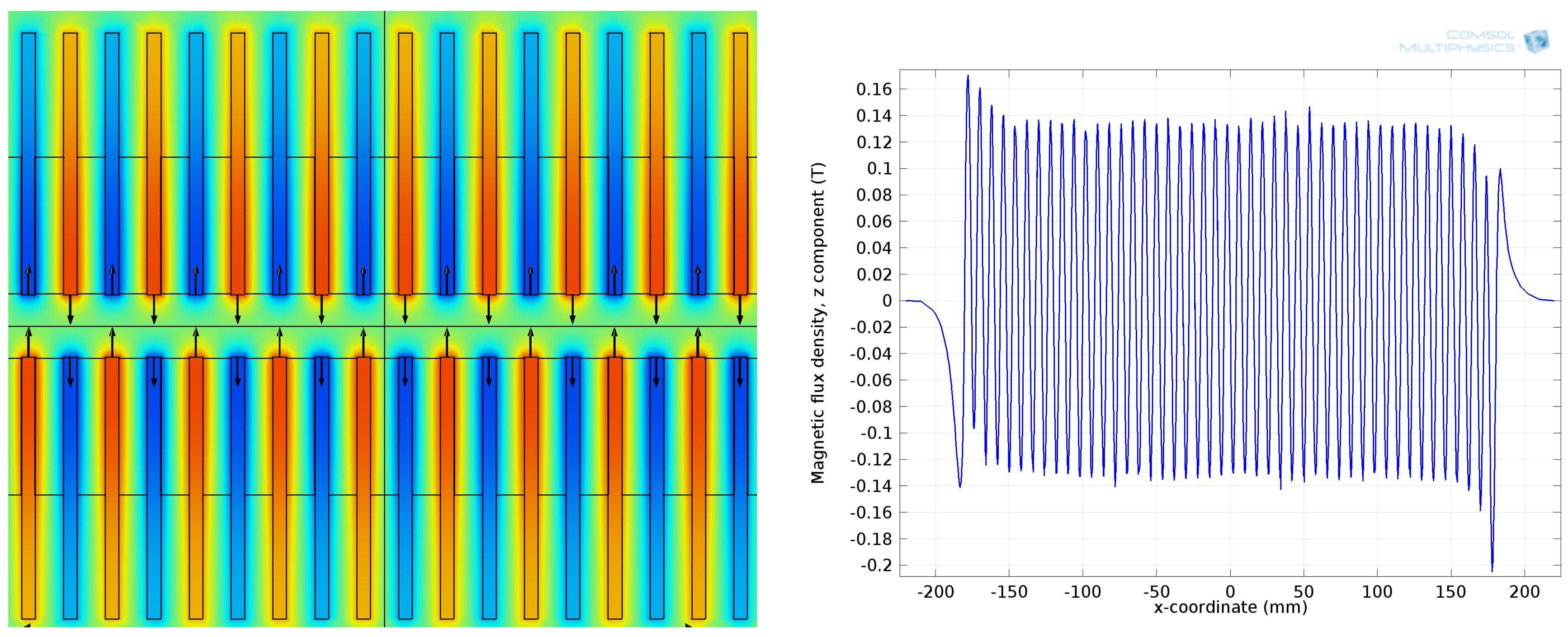

Figure 5. Magnetic Flux density in an undulator magnetic device (side view) and magnetic field measured at the gap in the z direction .

Magnetic devices	Experimental	COMSOL
Dipole maximum magnetic field	0,11 T	0,14 T
Quadrupole maximum magnetic field	0,054 T	0,035 T
Undulator avarege magnetic field	0,13 T	0,12 T

Table 1. Comparison of the magnetic field obtained from the simulation and experimental analysis in the dipole, quadrupole and undulator magnetic device.

Conclusions: Numerical simulation results are in agreement with the documented validating experiment. For the next step, an electron beam will be added and modeled using the *Particle Tracing Module* in order to study the behavior of the electron beam in magnetic elements.

References:

1. M. Tecimer, Time – Domanin analysis and technology of THz Free Electron Lasers, Tel – Aviv University. : Faculty of Engineering. Department of Electrical Engineering – Physical Electronics. , 2005.
2. J. G. L. R. E. Paul P. Tesch, "Final construction of the CREOL 8 mm period hybrid undulator,"Nuclear Instruments and Methods in Physics Research A375, pp. 504-507, 1996.
3. Srinivas Krishnagopal*, Vinit Kumar†, Sudipta Maiti, S. S. Prabhu and S. K. Sarkar, "Free-electron lasers.," CURRENT SCIENCE, VOL. 87,, pp. NO. 8, 25, OCTOBER 2004.

Excerpt from the Proceedings of the 2014 COMSOL Conference in Curitiba