

Experience and perspectives of using ELTA programs for teaching induction heating

A. Zenkov¹, A. Ivanov¹, V. Bukanin¹, V. Nemkov², M. Pervukhin³ and V. Timofeev³

¹St. Petersburg Electrotechnical University (LETI), 5, Prof. Popov Str., St. Petersburg, Russia, 197376

²Fluxtrol, Inc., 1388 Atlantic Blvd, Auburn Hills, Michigan, USA, 48326

³Siberian Federal University, 26a, Kirenskogo str., 660074, Krasnoyarsk, Russia



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Introduction

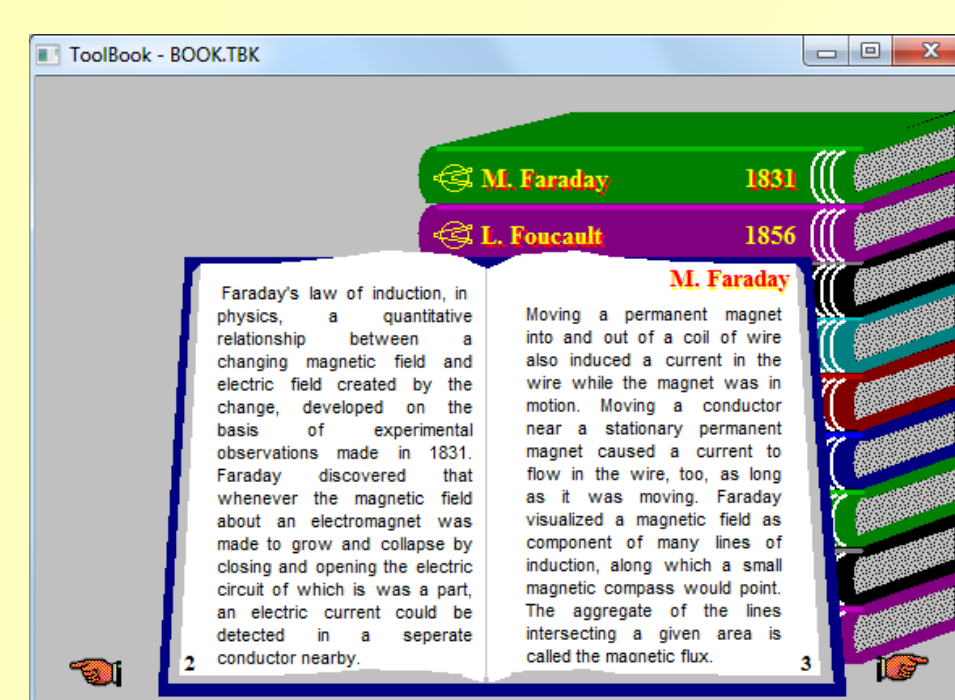
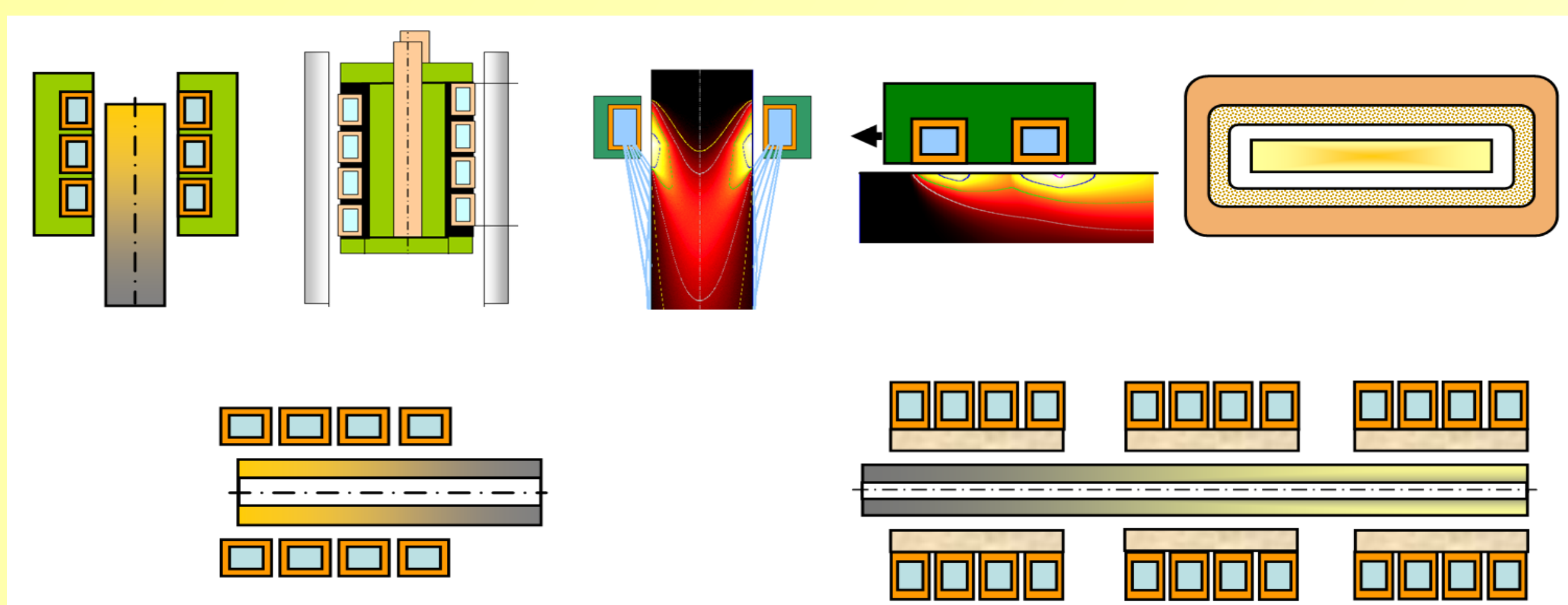
Experience of authors in teaching induction heating using subject-oriented programs is described. The preliminary study, teaching and training of the basics of induction heating process can be performed using subject-oriented and easy-to-use programs such as ELTA (ELectro Thermal Analysis) and 2DELTA (Two Dimensional variant of ELTA for cylindrical systems). ELTA and 2DELTA programs are designed with account for possibility to use them for the education and self-education process. Several examples for teaching, training or self-education are presented to demonstrate the basic electromagnetic and thermal phenomena of induction heating, such as skin, edge and end electromagnetic effects. ELTA and 2DELTA programs can be effectively used for design of various induction heating processes, including in-line heat treating of parts and multi-stage heating of billets and slabs.

Teaching and Training

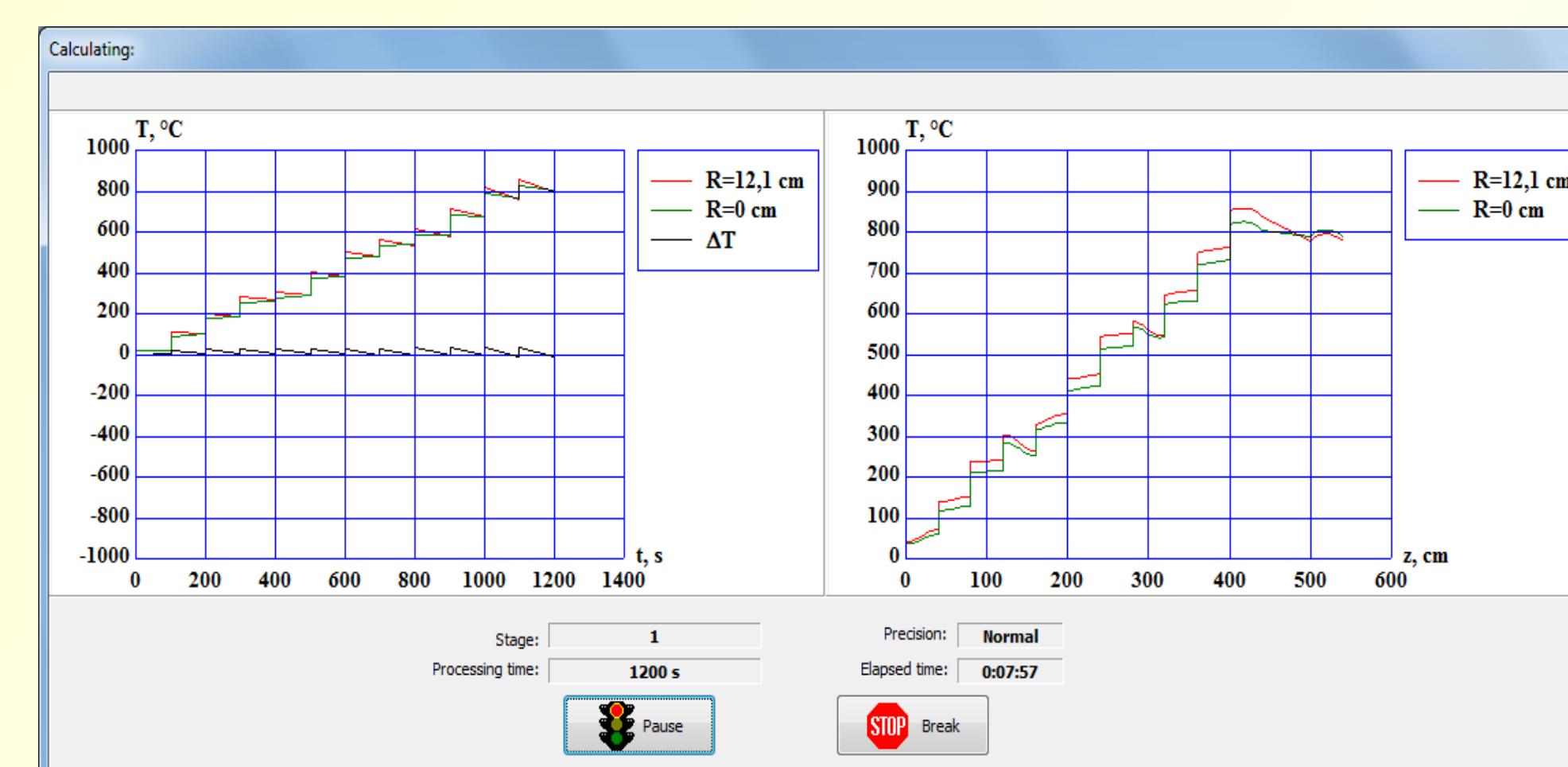
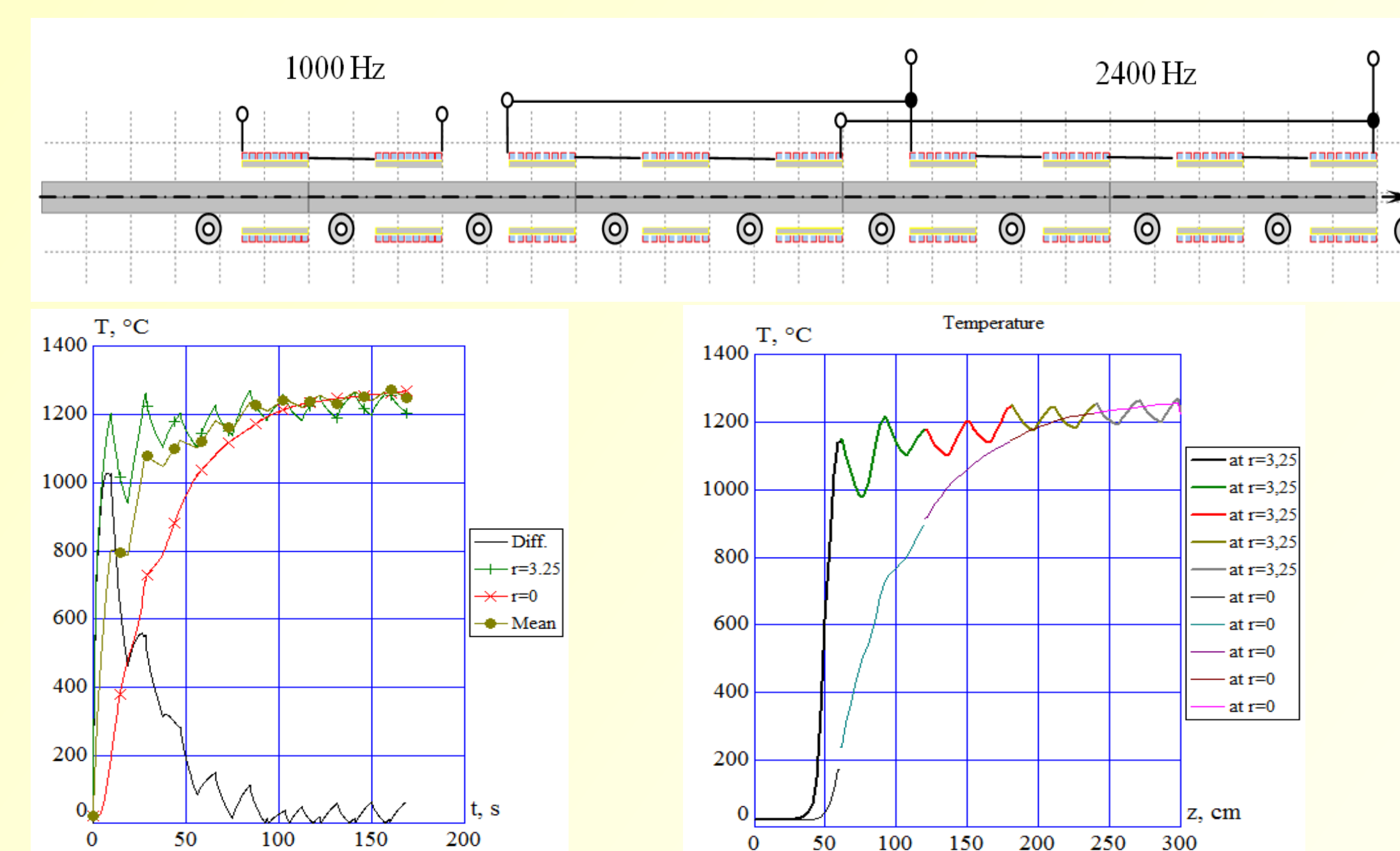
A course-book for research and practical exercises in the field of induction heating has been developed for graduate and postgraduate students, young practitioners and engineers.

A set of practical tasks in induction heating, based on computer modeling using the ELTA and 2DELTA programs, is included in the book.

The typical induction systems, which may be studied with ELTA 6.0

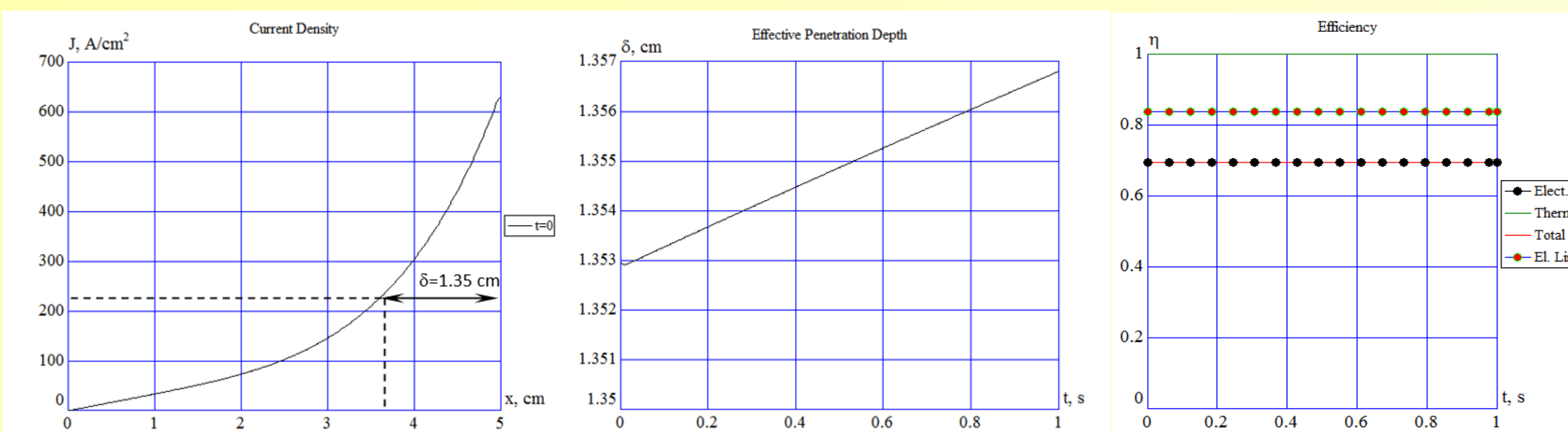


Study of two frequency induction heating in ELTA and 2DELTA



Basic phenomena of induction heating

Skin effect, effective penetration depth and threshold electrical efficiency

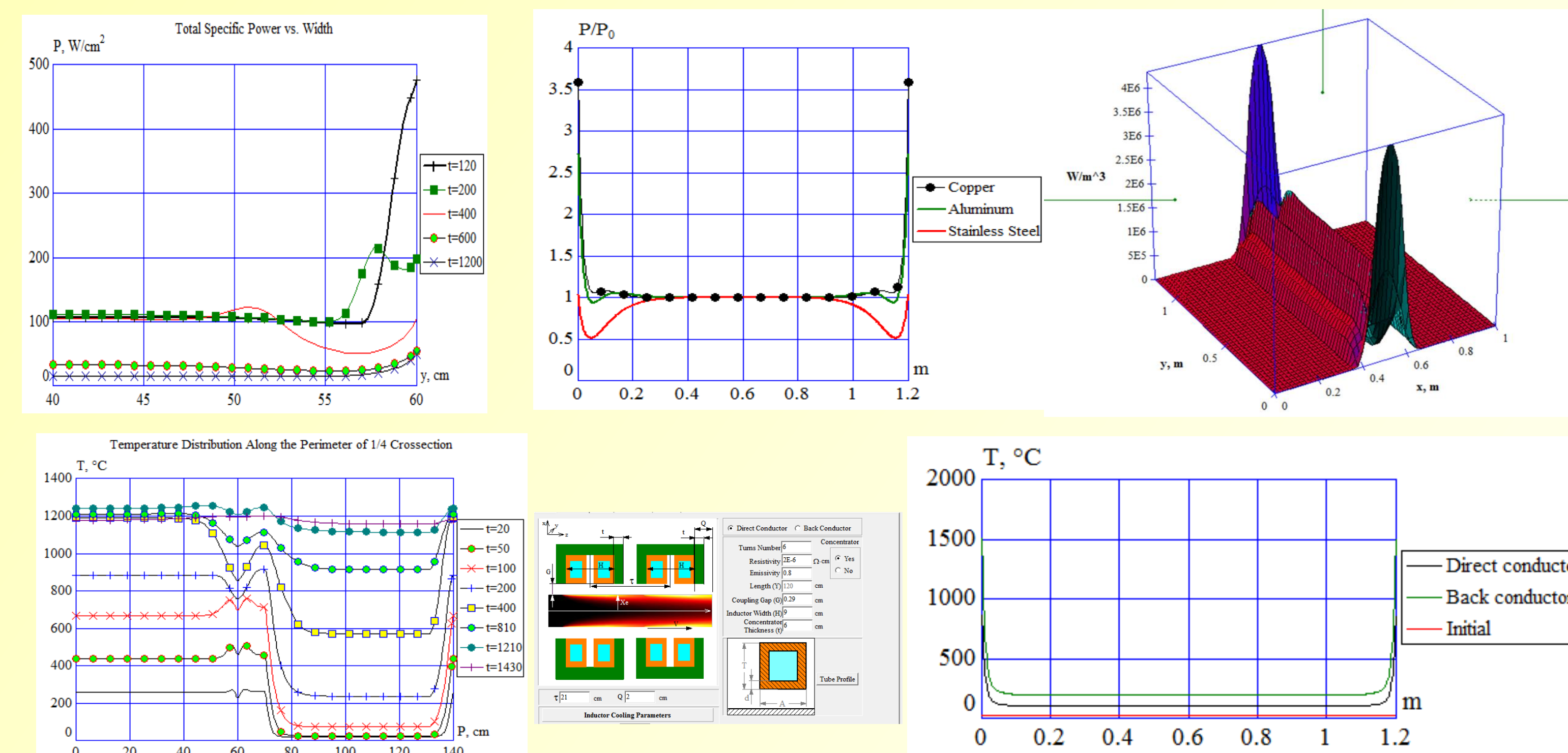


ELTA calculates the threshold value of electrical efficiency taken into account infinitely long system

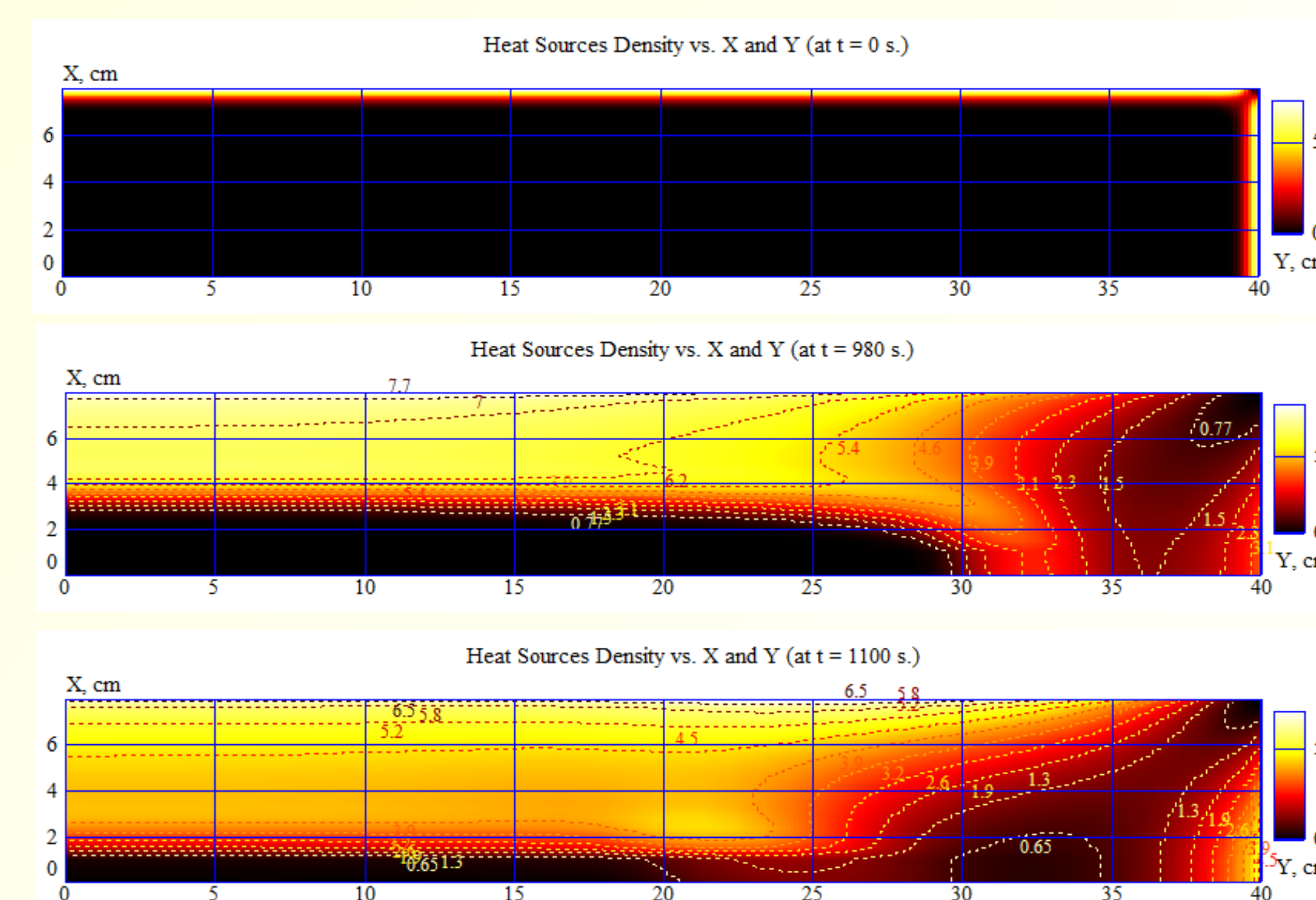
$$\eta_{lim} = \frac{1}{1 + \frac{\Delta R_i}{R_w N_i^2}}$$

where ΔR_i – minimal resistance of induction coil, R_w – real resistance of workpiece, N_i – turn number of inductor

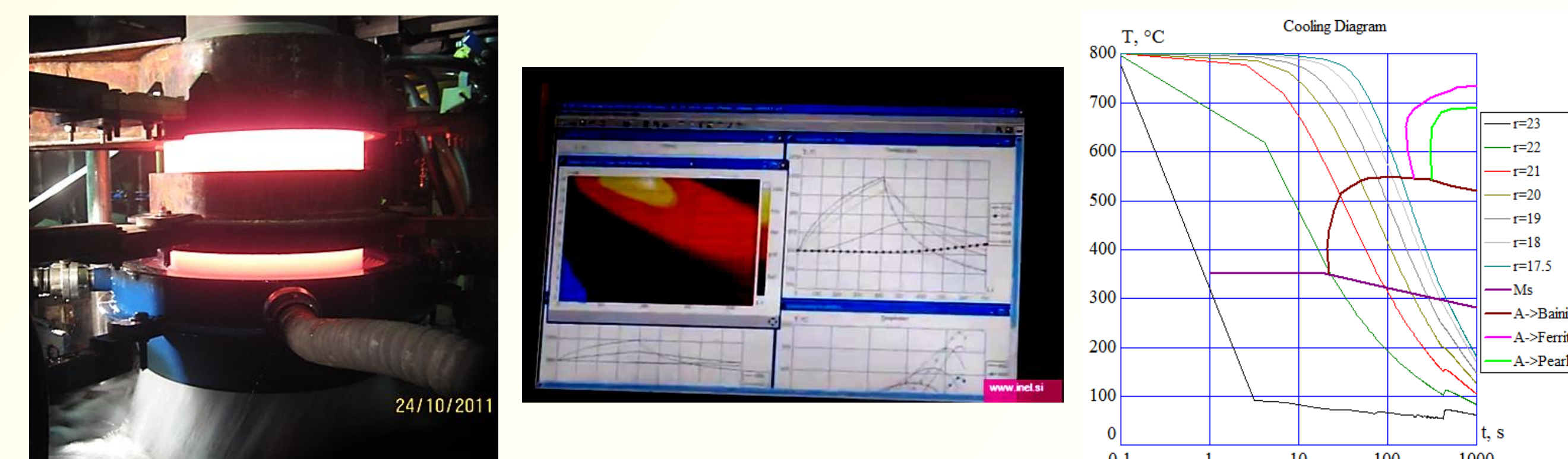
Edge effects of slab in rectangular induction systems and thin strips in transverse flux induction systems



ELTA can create animation of color maps. It is very convenient to see dynamics of temperature and power sources from educational point of view



Case studies of two frequency induction heat treatment with distribution of temperature during the cooling stage and CCT diagram of steel



Conclusion

ELTA and 2DELTA programs can be used for lectures, laboratory tasks, home exercises and remote education. Students are encouraged to develop their skills by doing focused exercises. Process of education starts from formulating the problem and creating the “task” and finishes with analysis of the results of calculations. It is very convenient feature for both education and practical use for system design.

More information may be found at: www.nsgsoft.com



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