



Project name:	Device for controlled electromagnetic excitation of culture wells
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Development motivation:

In biological research, various methods are used to stimulate cells in culture dishes, and one of the possible methods is stimulation with an electromagnetic field, see e.g [2]; This method has undergone great development in recent years and there is a great effort to develop a method that will allow the use of standard wells arranged in sterilized and standardized multi-well plates, e.g. [1]. In addition, the product developed must be capable of being used in the environment incubator type MCO-170AIC-PE (see Image 4), and evaluation using standard established methods. This project is being carried out at the Faculty of Mechatronics, Informatics, and Interdisciplinary Studies, and due to the required compatibility with the existing incubator, the development was consulted with the Faculty of Health Studies at the Technical University of Liberec.

Technology used:

1. The *Dragonfly LDM 2.0* technology of 3D printing of printed circuit boards (hereinafter referred to as "PCBs") from the manufacturer Nanodimension was used for the production of excitation and measuring coils, which enables the production of PCBs in a completely new way. Existing Multilayer PCB manufacturing technologies allow individual coil turns to be layered on the surfaces and thus by Sequential Built Up (SBU) technology from the innermost layers by adding additional layers of prepregs and metallic foils; Production takes place in the following steps:
 - Etching of the innermost layers of the motif.
 - Applying prepreg and Cu foil on both sides and pressing.
 - Drilling and plating buried via, filling holes (filled via) and strengthening the motif.
 - Etching the motif of the other two layers of the spool.
 - Repeat steps 2-3-4 until the total required number of layers (coils) is reached.

It therefore requires the repeated connection of a number of production machines from mechanical to chemical lines, and in addition to the production of common waste in the form of chemicals and wastewater, it is also necessary to take into account large technological waste in the form of removal of the technological surroundings of the motif.

Our project uses a single machine for production and apart from the liquid for cleaning the printing nozzles, it does not generate any waste, the production consists of uploading print data and starting the printing procedure. The same data can be used as print data as in the production of traditional technologies (Gerber + Excellon) from the traditional eCAD design system, but since the main advantage of eCAD, i.e. the autorouter, cannot be used in the case of specialized and highly sophisticated motifs, it is possible to use a traditional 3D CAD modeling tool when preparing print data. In this case, we can also use spatial generators, to take full advantage of the possibilities of the 3D space intended for the placement of the motif, in this case the spatial coil.



Although for the use of coils outside the cultivation wells, due to the required cleanliness of the experimental environment, it is appropriate to state that the biocompatibility of the coil material according to EN ISO 10993-5, compliance according to DIN EN ISO/IEC 17025 has been proven in cooperation with the manufacturer, and the UL certificate 14847193 also states that it is safe to health. The products can thus be used in both in-vitro and in-vivo medical applications and are suitable for medical clinical research.

2. For several practical reasons, the *Prusa CORE One+* printer [3] was used for the production of the supporting structure, the parameters of which fully meet the requirements for the size of the print area and the accuracy of the structure. The material used for the PET-G supporting structure then ensures dimensional stability, resistance to chemicals used in sterilization of the product and, last but not least, safe use from the point of view of health and the environment.

The resulting design is reconfigurable to the maximum extent possible, i.e. it is possible to freely add individual coils, connect them to individual terminals of the jig connectors; The connection of the product outside the culture chamber is ensured by flat cables allowing quick disconnection and easy handling. Outside the culture chamber, it is possible to connect experimental electronics as needed – generators, measuring instruments, etc. And it is possible, for example, to excite the required electromagnetic field with one coil and use the surrounding coils to monitor the impact of the signal on neighboring wells, or to interact with this field in an appropriate way.

For the experiments with the biomaterial themselves, standardized multi-well plates are used with the possibility of changing the experiment in the form of simple plate replacement without the use of any tools. Thanks to this well-thought-out design, it is therefore also possible to use already established evaluation procedures to monitor the result of the experiment, i.e. the change of the cell cultures used under a microscope or in other evaluation instruments.

The created sample is in the phase of practical evaluation and in case of successful verification, a project is prepared for continuous online evaluation of changes in cultivation wells.

Connectors used:

- Cable Connectors: IDC; plug; female; PIN: 16; IDC; for ribbon cable; 2mm, Connfly marking: DS1017-16MA2
- Connector in the device: IDC; socket; small; PIN: 16; angled 90°; THT; 2mm; 2x8, Connfly designation: DS1014-16RF1B



Picture attachment:

On Image 1 it is shown the whole assembled device, i.e. the upper and lower parts of the mechanical structure, (only) five coils are inserted into the prepared holes, which are connected inside the structure by wire jumper to one of the three connectors – so there is sufficient space for robust connection of all coils to these connectors.

Image 2 presents a product with a multi-well plate attached – this is how a complete culture product is created; during the implementation of the experiments themselves, it is only possible to replace the multi-well plate with new samples, change the excitation parameters, or configure externally connected instruments, and it is possible to start a new experiment within a short time.

Image 3 represents a view through a well to a coil located under the bottom of the plate.

On Image 4 the MCO-170AIC-PE incubator in use is shown (details and parameters are available at the link [4])

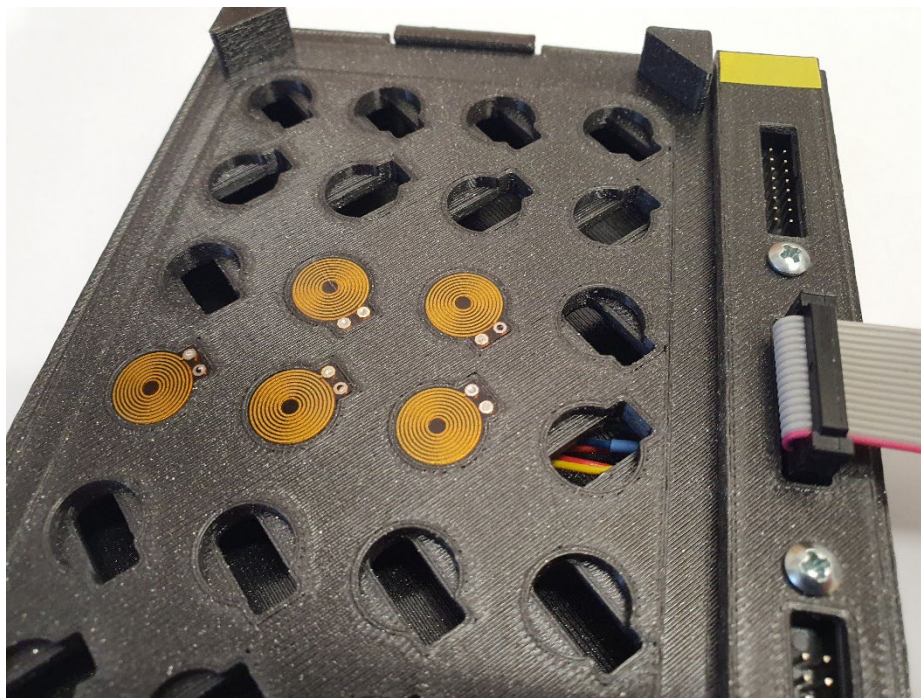


Image 1 - Assembled device



Image 2 - Device with fitted multi-well plate



Image 3 - View of the multi-well plate (without the lid)



Image 4 – Incubator MCO-170AIC-PE

Sources:

- [1] *Multi-well plate, matrix 4×6*. Online. S.d. Available from: <https://www.sigmaldrich.com/CZ/cs/product/sigma/cls353047>. [cit. 2026-03-25].
- [2] Piotrkowska, D.; Siwak, M.; Adamkiewicz, J.; Dzik, L.; Majsterek, I. The Therapeutic Potential of Pulsed Electromagnetic Fields (PEMF) and Low-Intensity Pulsed Ultrasound (LIPUS) in Peripheral Nerve Regeneration: A Comprehensive Review. *Int. J. Mol. Sci.* **2025**, *26*, 9311. <https://doi.org/10.3390/ijms26199311>
- [3] *Prusa CORE One+ kit*. Online. S.d. Available from: <https://www.prusa3d.com/cs/produkt/prusa-core-one-kit/>. [cit. 2026-03-26].
- [4] *IncuSafe CO2 Incubator MCO-170AIC-PE*. Online. S.D. Available from: <https://www.phchd.com/eu/biomedical/incubation/CO2incubators/mco-170aic>. [cit. 2026-04-05].