# Contactless Magnetic Manipulation as a Key Technology for Micromanufacturing and Microrobotics

## How the Magnetic Particle Mover from SEKELS can support the contactless assembly of the smallest components and the actuation of magnetic microrobots in the future.

### Starting Point: Limits of Mechanical Handling

In micromanufacturing and microrobotics, conventional contact-based handling quickly reaches its physical limits. At the micro- and nanoscale, surface and adhesion forces dominate over gravitational force – making the gripping, transport and controlled release of the smallest objects a challenge. Added to this is the lack of installation space for mechanical actuators directly at the object.

Magnetic methods circumvent these problems: they act without contact, penetrate vessels and encapsulations, and can be programmed precisely. For this purpose, the **Magnetic Particle Mover** from SEKELS GmbH uses a patented arrangement of a Halbach dipole and two rotatable quadrupole rings, with which the magnetic field and field gradient can be adjusted independently in amplitude and direction.

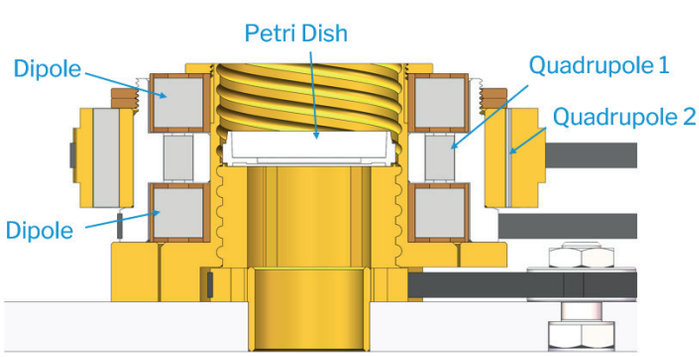


*Fig. 1: Cross-section through the magnet system – dipole and two quadrupole rings enclose the sample chamber.*

### Application Perspective: Micromanufacturing Technology

For micromanufacturing, contactless field control opens up new possibilities for non-contact assembly and positioning. Magnetizable microcomponents can be specifically moved, aligned and joined without a mechanical gripper touching the sensitive parts. International research already shows that magnetic microactuators can be used to grip, transport and place multiple objects at defined assembly positions in a single working cycle.

- **Contactless micro-assembly:** positioning and joining of the smallest magnetic components without mechanical contact – gentle on sensitive surfaces.
- **Parallel handling:** simultaneous control of multiple particles or components, which would be virtually impossible to achieve mechanically.
- **Reproducibility:** programmable trajectories and macros as the basis for automatable, repeatable manufacturing steps.
- **Micromixing & process support:** magnetically actuated microactuators improve mixing and reaction kinetics in microfluidic manufacturing and coating processes.

## Application Perspective: Microrobotics

The second major field of the future is microrobotics. Here, magnetic fields are considered an ideal source of energy and control, as they are wireless, deeply penetrating and biocompatible. The ring-based field system of the Magnetic Particle Mover in future can serve as an actuation platform to controllably drive magnetically functionalized microrobots, soft microgrippers or helical swimmers.

The extent to which this field has already been advanced is demonstrated by the research of the **Multi-Scale Robotics Lab (MSRL) at ETH Zurich** led by Prof. Bradley Nelson and Prof. Salvador Pané. For years, magnetically controlled microrobots for minimally invasive medicine have been developed there. In a study published in Science in 2025, the team presented clinically ready microrobots: gel-based capsules with iron oxide nanoparticles that are steered through blood vessels via a modular electromagnetic navigation system – with a success rate of over 95% in drug delivery at the target site.

Remarkable is the combination of three navigation strategies: rolling the capsule along the vessel wall via a rotating field, pulling it via a field gradient – even against a flow of more than 20 cm/s – as well as flow-guided navigation at bifurcations. It is precisely these principles of a rotating field and an adjustable gradient that also form the physical foundation of the Magnetic Particle Mover and underline the compatibility of SEKELS technology with leading international research.

*Fig. 2: 3D guider prototype – extension of field control into three-dimensional space.*


**Sources**

sekels.de · particlemover.com · ETH Zurich, Multi-Scale Robotics Lab (msrl.ethz.ch); Landers F. C. et al., "Clinically ready magnetic microrobots for targeted therapies", Science 390 (6774), 710–715 (2025), DOI: 10.1126/science.adx1708.


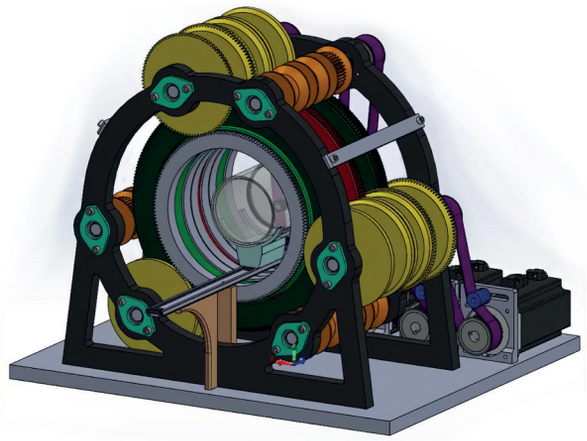

*Fig. 3: CAD model of the scaled 3D system (Ø 200 mm) for larger working spaces.*

## From Demonstrator to Scalable Platform

The current 2D setup and the 3D guider prototype (inner diameter 100 mm, 3D-printed) demonstrate the functionality. For more demanding manufacturing and robotics tasks, a scaled variant with a 200 mm inner diameter in an aluminium-brass design is planned, complemented by a controllable specimen stage. This grows the system from a laboratory tool into a platform for larger working spaces and integrated processes.

## Conclusion

Micromanufacturing technology and microrobotics share the same core requirement: precise, reproducible and contactless control of the smallest objects. With its patented Halbach field system, the adjustable combination of field and gradient, and real-time software, the Magnetic Particle Mover addresses exactly this requirement. The work at ETH Zurich impressively demonstrates the medical potential of magnetic microrobots – the SEKELS platform can provide the underlying field control as an accessible, scalable tool for research, manufacturing and development.

### About SEKELS GmbH

SEKELS GmbH (Ober-Mörlen, Germany) is a specialist in magnetic fields, materials, magnet systems and magnetic shielding, and is developing the Magnetic Particle Mover, a system for the contactless control of magnetizable particles.


**Contact** ▸ Dr. Stefan Hiebel
+49 6002 9379-46
shiebel@sekels.de
particlemover.com