EuroMagNET: A Coordinated Approach to Access, Experimental Development and Scientific Exploitation of European Large Infrastructures for High Magnetic Fields

Electromagnets powerful enough to crush themselves under the strength of their own magnetic fields sound like science fiction but, in fact, plenty of everyday research depends on magnets that are only slightly less strong. The EU-funded EuroMagNET project is providing transnational access to Europe's most important research institutions specialising in high-magnetic fields. The project is also developing research activities to make the best possible use of these infrastructures, and pushing the boundaries of magnet-based analytical techniques.

ATTRACTIVE SCIENCE

Inside many a machine is a magnet. Small machines, like computer hard drives and CRT monitors, have tiny but powerful magnets. Large machines, like hospital MRI scanners, mass spectrometers and the particle accelerators used in nuclear physics, have large magnets. Electric motors, loudspeakers and transformers are other common devices that depend on magnetic fields for their operation.

The strongest kind of ordinary permanent magnet, a neodymium-boron or 'rare-earth' magnet, has a field of less than 2 Tesla (T) – enough to break a finger that gets between the magnet and a heavy steel object. MRI scanners use magnetic fields that are actually no stronger than 2 T at the centre of the machine, though their huge superconducting electromagnets produce wide-reaching fields that can suck in steel objects as large as an office chair.

But when physicists talk about strong magnetic fields, they mean a lot more than 2 T. The most powerful superconducting electromagnets available today can produce steady fields of more than 20 T, and non-superconducting ('resistive') electromagnets can reach more than 30 T. Even stronger fields, possibly up to 100 T, are produced by energizing electromagnets with short pulses of electricity from a capacitor bank or a special type of generator.

Keeping the current pulses short ensures that the magnet coils do not melt, but that still leaves magnet designers with another problem. Even with state-of-the-art materials, it is difficult to build a large magnet that will not implode under the forces generated by its own magnetic fields and currents. In fact, the very highest fields (1 000 T for a period of a few microseconds) come from single-use electromagnets that self-destruct when they are switched on.

Engineers go to all this trouble because strong magnetic fields have all kinds of uses in research, especially materials science and the physics of condensed matter. One important application is the study of high-temperature superconductivity, which may one day allow electricity to be generated and transmitted without resistive losses – as well as allowing us to build bigger and better electromagnets.

CREATING A STRONGER RESEARCH FIELD

Europe has several research facilities dedicated to producing very high-magnetic fields. The purpose of the EuroMagNET project is to make the best use of these by networking the facilities and by carrying out research aimed at improving access to the magnets.

Transnational Access for researchers from across Europe is one of the functions of EuroMagNET. Successful applicants are able to book time at one of three large facilities offering static and pulsed fields, at Nijmegen (The Netherlands), Toulouse (France) and Dresden (Germany) or a number of smaller pulsed-field magnets.

EuroMagNET's two Joint Research Activities, meanwhile, link with other research groups to allow the existing magnet laboratories to undertake new types of experiments in high-field nuclear magnetic resonance (NMR) and infrared spectroscopy in pulsed fields.

EUROPEAN COMMISSION

Finally, EuroMagNET fosters exchange of information between the different magnet laboratories and various user groups. The aim is to create a network of scientific groups whose common interest is the use of high-magnetic fields, and to involve scientists from areas in which magnet research is less familiar. The networking activities include yearly topical workshops and a summer school for young scientists.

A COORDINATED APPROACH TO ACCESS, EXPERIMENTAL DEVELOPMENT AND SCIENTIFIC EXPLOITATION OF EUROPEAN LARGE INFRASTRUCTURES FOR HIGH MAGNETIC FIELDS IN SUMMARY

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