EMFL – Plans for a European High Magnetic Field Facility

O. Portugall[1], G. Rikken[1], J. K. Maan[2] and J. Wosnitza[3]

[1] LNCMI Grenoble & Toulouse, France
[2] HFML Nijmegen, The Netherlands
[3] HLD Dresden, Germany

Science in high fields

Magnetic fields act on charges and spins. Their capability to influence matter reversibly, without intrusion, makes them a useful tool to

- **manipulate** (deflection, levitation, separation, alignment, acceleration),
- **probe** (nuclear magnetic resonance, electron spin and cyclotron resonance, Hall-effect and magneto-resistance),
- **induce new fundamental states** (field-induced supraconductivity, normal state of superconductors, magnetic phases).

High magnetic fields have played an essential role in discoveries rewarded by 15 Nobel prizes.

High-field X-ray scattering setup (LNCMI-ESRF).

High magnetic field generation

The generation of high magnetic fields is technically limited by several physical phenomena.

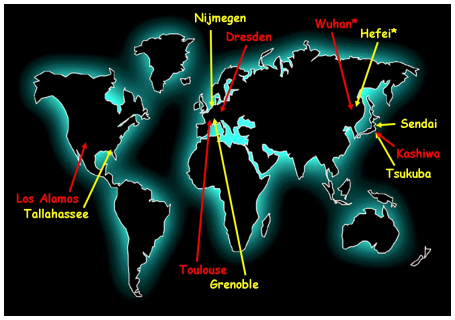
- **Critical field of superconductors:** 25 T limit for generating magnetic fields dissipationless.
- **Joule heating of electrical conductors:** 36 T limit for static fields (resistive only). 45 T limit for static fields (hybrid).
- **Lorentz forces:** 90 T limit for non-destructive pulsed fields.
- **Magnetic flux diffusion:** 300 T limit for destructive single-turn coils, 700 T limit for in-door flux compression.

Capacitor bank for pulsed field generation.

User facilities worldwide

The technical difficulty of generating high magnetic fields has given rise to a centralization of research activities in a few large user facilities that are based on four corner stones:

- the development of cutting-edge magnet technology,
- the development of suitable experimental techniques,
- an extensive in-house research programm,
- the accommodation of external users on a regular basis.

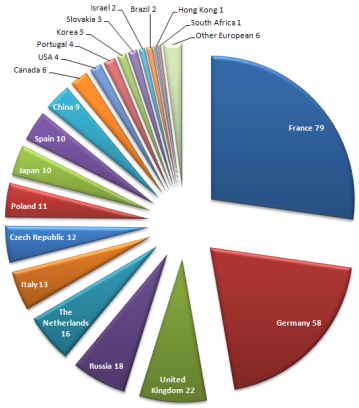


*User facilities for pulsed (red) and static (yellow) magnetic fields. Installations marked by * are under construction.*

The EuroMagNET consortium

EuroMagNET (www.euromagnet2.eu) comprises the 4 largest European magnet facilities as core-partners. Installations are open to external users whose projects have been validated by an international selection committee. Calls for proposals are issued twice a year. Financial support for European users is provided through the Transnational Access (TNA) programme.

- **HLD Dresden, Germany** – pulsed magnetic fields up to 87 T; access to the THz-FEL ELBE; project for a 100 T non-destructive magnet.
- **HFML Nijmegen, The Netherlands** – static magnetic fields up to 33 T; constructions of a THz-FEL and 44 T hybrid magnet underway.
- **LNCMI Grenoble, France** – static magnetic fields up to 35 T; 43 T hybrid magnet under construction.
- **LNCMI Toulouse, France** – pulsed fields up to 80 T, ultra-short 300 T fields and mobile generators for experiments at other large facilities.



Project proposals per country received by EuroMagNET in 2009. Asia represents the second largest user group after Europe.

Eurasian perspectives

The EuroMagNET partners maintain collaborations with high-field facilities in China and Japan as well as other laboratories in Asia. These need to be intensified to counterbalance the American supremacy and to cope efficiently with issues related to the operation of large-scale installations. Some issues to be addressed are:

- **Joint scientific projects** – make use of the complementarity of experimental techniques available in different facilities.
- **Joint technological development** – avoid redundancy and limit the individual investment in cost-intensive areas.
- **Outsourcing** – identify industrial partners to take over tasks of routine production; enhance prototype development in exchange.
- **Purchasing** – coordinate the acquisition of raw materials so as to improve industrial partnerships.

The EMFL project

EuroMagNET is funded on a 4-year basis by the European Commission. In order to consolidate and improve the free access to high magnetic fields for the international user community, it is planned that the existing network will evolve into a distributed infrastructure, the European Magnetic Field Laboratory (EMFL).

As of 2008, the EMFL project has been integrated in the ESFRI roadmap for European large installations. The corresponding preparatory phase proposal is under evaluation.

Contact

HLD Dresden, Germany
Jochen Wosnitza – j.wosnitza@fzd.de

HFML Nijmegen, The Netherlands
Jan Kees Maan – jc.maan@science.ru.nl

LNCMI Grenoble & Toulouse, France
Geert Rikken – geert.rikken@lncmi.cnrs.fr
Oliver Portugall – oliver.portugall@lncmi.cnrs.fr