

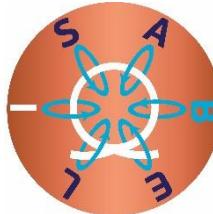
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## ISABEL

### Improving the sustainability of the European Magnetic Field Laboratory

#### WORKSHOP PROCEEDINGS x 4

#### REPORT



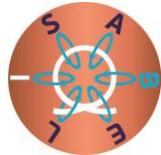
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1.0	First draft	15/12/2023	Jérôme Béard, Fabienne Duc, Uli Zeitler, Thomas Hermannsdoerfer, Shingo Yamamoto, Peter Christianen
2.0	Final version	22/01/2024	Eva Bezgousko ISABEL Board



## DOCUMENT ABSTRACT

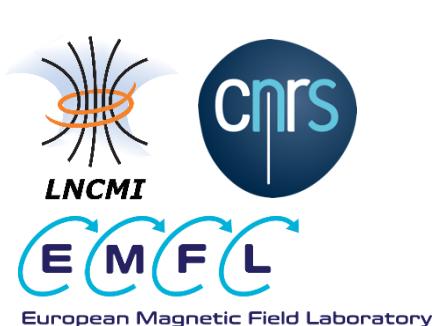
During the second reporting period of ISABEL, four workshops have been organized in France, the Netherlands and Germany, each targeting major advanced research infrastructures sources (neutrons, x-rays, THz radiation, high-power lasers). The main objective was to develop the scientific case for high-field experiments at such advanced sources, and to make an inventory of the needs of the users in terms of magnet characteristics, instrumentation and organisation.

This deliverable 6.1 is part of Work Package 6, “Collaboration with other European RIs”. It compiles the four reports from the four workshops performed.

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## Report on the Workshop “Perspectives of High Magnetic Fields at Neutron Sources” HMF@NS

Grenoble, France - November 2-4, 2022

This workshop was co-organized by staff from the Laboratoire National des Champs Magnétiques Intenses (F. Duc, LNCMI-Toulouse), the Institut Laue Langevin (M. Boehm, E. Lelièvre-Berna, B. Dubouloz, ILL) and the Dresden High Magnetic Field Laboratory (S. Chattopadhyay). It was financially supported by the European project [ISABEL](#)<sup>1</sup> and the [ILL](#). The venue was the EPN Science Campus, Grenoble (Chadwick amphitheatre, ILL, Guest House for participants). It was held in hybrid mode (both in-person and virtual).

This workshop gathered scientific and technical experts of high-field and neutron facilities with the aim of identifying the needs of the neutron community, evaluating the technical challenges, and preparing a roadmap for developing unprecedented capabilities. It had 64 registered participants, coming mostly from Europe. It consisted of 22 invited contributions on scientific and instrumental aspects, organized in the sessions described below. Ample time was reserved for discussions after and between presentations.

### Inspiration for the use of high-B fields

Studies of magnetism, superconductivity and quantum systems with neutrons is a vibrant research area, which is underpinning a new generation of devices as well as leading to a deeper understanding of Nature at a fundamental level. During this first session, the participants discussed how invaluable the ability is to reach higher magnetic fields for exploring new states of matter and what the most efficient ways are to exploit neutron beams with high-field magnets.

### Experience with pulsed fields | Science & Techniques

Pulsed magnetic field set-ups/devices reaching up to 40 T have been developed over the past 15 years for carrying out neutron diffraction experiments. During this session, we got an overview of the science produced so far and the technical difficulties that have been solved with great success. The perspectives toward much higher magnetic fields and extended duty cycle have also been discussed.

### Experience with static fields | Science & Techniques

Since the recent shutdown of the HZB neutron source and despite the continuous development of superconducting magnets for decades, the highest static magnetic fields currently available at neutron facilities do not exceed 15 to 17 tesla. During this session, the experience gained with the 26 T HZB magnet and the desired capabilities of future extreme-field magnets were discussed, including sample volume, temperature and pressure, magnet geometries, and auxiliary measurement techniques.

### Perspectives & Projects | Specifications & Roadmap

Following the presentations of recent scientific and instrumental breakthroughs, the latter session was the occasion to discuss the state of the art and identify paths toward the collaborative development of modern high-field magnets for neutron scattering facilities.

<sup>1</sup> This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 871106

## Program

	Wednesday 2/11		Thursday 3/11		Friday 4/11	
			Experience with pulsed fields - Science & Techniques		Perspectives and Projects - Specifications & Roadmap	
08:30 - 09:00		08:30 - 09:00	Ellen Fogh	08:30 - 09:00	Jérôme Béard	
09:00 - 09:30		09:00 - 09:30	William Knafo	09:00 - 09:30	Matthew B. Stone	
09:30 - 10:00		09:30 - 10:00	Philip Moll	09:30 - 10:00	Anis Smara	
Break 30'		Break 30'		Break 30'		
10:30 - 11:00		10:30 - 11:00	Alexander Steppke	10:30 - 11:15	Arnaud Badel - Eddy Lelièvre-Berna - Taotao Huang - X. Tonon	
11:00 - 11:30		11:00 - 11:30	Fabienne Duc			
11:30 - 12:00		11:30 - 12:00		11:15 - 12:00	Discussion and conclusion	
Lunch		Lunch		Lunch		
14:00 - 14:10	Welcome - Eddy Lelièvre-Berna, Fabienne Duc, Paul Langan		Experience with static fields - Science & Techniques			
14:10 - 14:30	Geert Rikken - Introduction ISABEL	14:00 - 14:30	Oleksandr Prokhnenco			
	Inspiration for the use of high-B fields					
14:30 - 15:00	Elizabeth Blackburn	14:30 - 15:00	Stephan Allenspach			
15:00 - 15:30	Daniel Mazzone	15:00 - 15:30	Karel Prokes			
Break 30'		Break 30'				
16:00 - 16:30	Claudia Felser	16:00 - 16:30	Sebastian Mühlbauer			
16:30 - 17:00	Marc Janoschek	16:30 - 17:00	Javier Campo			
17:00 - 17:30	Astrid Schneidewind	17:00 - 17:30	Xavier Chaud			
19:00 - 22:00	Dinner : Wine and Cheese	20:00 - 23:00	Workshop dinner			

## Contribution list

**02/11/2022 14:00:** Welcome by the ILL Director and the Organisers

Dr Eddy Lelièvre-Berna (ILL), Dr Fabienne Duc (LNCMI Toulouse), Dr Paul Langan (ILL)

**02/11/2022 14:10:** Introduction by the ISABEL coordinators of the Relations with EU Research Infrastructures

Dr Geert Rikken (LNCMI - Laboratoire National des Champs magnétiques Intenses)

**02/11/2022 14:30:** Exploring the ways in which superconductivity breaks down close to the upper critical field  
Prof. Elizabeth Blackburn (Lund University)

**02/11/2022 15:00:** Horizontal field cryomagnets: Research opportunities for correlated quantum phenomena  
Dr Daniel Mazzone (PSI - Paul Scherrer Institute)

**02/11/2022 16:00:** Magnetic materials and topology

Dr Claudia Felser (MPI - Max Planck Institute)

**02/11/2022 16:30:** Probing electronic correlations of quantum matter at high magnetic fields

Dr Marc Janoschek (PSI - Paul Scherrer Institute)

**02/11/2022 17:00:** Extending the ( $H, T$ ) space to high fields for better understanding of exciting phenomena

Dr Astrid Schneidewind (MLZ - JSNS)

**03/11/2022 08:30:** Neutron scattering experiments with pulsed magnetic fields — today and tomorrow

Dr Ellen Fogh (EPFL — École Polytechnique de Lausanne)

**03/11/2022 09:00:** Metamagnetism and superconductivity in UTe2

Dr William Knafo (LNCMI - Laboratoire National des Champs magnétiques Intenses)

**03/11/2022 09:30:** Physics in ultra-high magnetic field: taking materials to the extreme

Dr Philip Moll (Max Planck Institute for the Structure and Dynamics of Matter - Hamburg)

**03/11/2022 10:30:** Insights from developing a pulsed field system for SwissFEL

Dr Alexander Steppke (PSI - Paul Scherrer Institute)

**03/11/2022 11:00:** Pulsed magnetic fields for neutron diffraction: technical challenges and scientific opportunities

Dr Fabienne Duc (LNCMI - CNRS)

**03/11/2022 14:00:** Neutron scattering in magnetic fields up to 26 T using HFM/EXED facility

Dr Oleksandr Prokhnenco (HZB - Helmholtz-Zentrum Berlin)

**03/11/2022 14:30:** Investigating field-induced magnetic order in Han Purple by neutron scattering up to 25.9 T

Dr Stephan Allenspach (PSI - Paul Scherrer Institute)

**03/11/2022 15:00:** Neutron studies in high static magnetic fields: Application to some Uranium systems

Dr Karel Prokes (HZB - Helmholtz-Zentrum Berlin für Materialien und Energie)

**03/11/2022 16:00:** Next generation asymmetric horizontal SANS magnet for quantum phenomena in nanostructures and correlated electron systems - Dr Sebastian Mühlbauer (FRM II - Forschungs-Neutronenquelle Heinz Maier-Leibnitz)

**03/11/2022 16:30:** Neutron scattering experiments with high magnetic fields in organic magnets  
Dr Javier Campo (ICMA - Instituto de Ciencia de Materiales de Aragón)

**03/11/2022 17:00:** HTS insert based on the metal-as-insulation winding technology as a step forward to very high field superconducting magnet

M. Xavier Chaud (LNCMI - Laboratoire National des Champs magnétiques Intenses)

**04/11/2022 08:30:** State of the art and perspectives of LNCMI pulsed magnets at neutron sources  
M. Jérôme Béard (LNCMI - CNRS)

**04/11/2022 09:00:** Neutron scattering with high magnetic fields at SNS and HFIR  
Dr Matthew B. Stone (ORNL - Oak Ridge National Laboratory)

**04/11/2022 09:30:** Recent advances in and outlook into second generation (2G) high-temperature superconductor tape technology - M. Anis Smara (Theva Dünnschichttechnik GmbH)

**04/11/2022 10:30:** Short and mid-term prospects of HTS conductors in high-field split magnets for neutron scattering - Dr Arnaud Badel (Institut Néel - CNRS), Dr Eddy Lelièvre-Berna (ILL), M. Taotao Huang (HTS-110), M. Xavier Tonon (ILL)

**04/11/2022 11:15:** Discussion and conclusion

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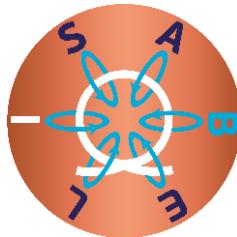
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European Magnetic Field Laboratory



## Report on the Workshop on Magnetic Fields in Laboratory High Energy Density Plasmas

*Paris-Palaiseau, France - December 19-21, 2022*

This workshop was co-organized by staff from the Laboratoire National des Champs Magnétiques Intenses and the Laboratoire pour l'Utilisation des Lasers Intenses. It was financially supported by the European project ISABEL and the International Research Network MHEDP. The venue was the first day at the Sorbonne Université in Paris and the two following days on the Campus of Ecole Polytechnique in Palaiseau. A visit of the recently commissioned multipetawatt laser Apollon has been organized the second day.

This workshop gathered scientific and technical experts of high-field and power-laser facilities with the aim of identifying the needs of the high energy density physics community, evaluating the technical challenges, and preparing a roadmap for developing unprecedented capabilities. It has been a success with 51 registered participants from all over the world.

It consisted of 37 invited contributions on scientific and instrumental aspects, organized in the sessions described below. Time was reserved for discussions after each presentation.

### **Needs of high-B fields combined with plasmas generated thanks to high power lasers**

B-field generation in laser-produced plasma environments to study scaled astrophysical phenomena or inertial confinement fusion processes has become a major trend nowadays. However, there still exists some limiting factors to perform specific investigations that could be overcome in developing new B-field generation capabilities. The first one, on the macroscopic scale, is to increase the B-field strength, while keeping large access to the plasma, to have a magnetic pressure in the range of the GPa (corresponding to  $\sim 60$  T) to study the impact of the B-field on the (i) equation of state, (ii) opacity and (iii) phase transitions of materials under dynamic compression. On the microscopic scale, it is also interesting to increase the B-field amplitude to increase the electron gyrofrequency in order to reach a few % of the electron plasma frequency

(typically  $10^{15}$  in laser-plasma experiment), for example for solar-burst studies. In parallel, the accesses to the plasma inside the coil could be increased to implement more diagnostics (for example multi-angle Thomson scattering, X-ray radiography,...) to better constrain the measurement. Finally, a path towards having a well-controlled B-field gradient could lead to a new investigation focused on collisionless shocks and particle acceleration, or penetration of a plasma in a magnetic field.

Pulsed magnetic field set-ups/devices reaching up to 40 T have been developed over the last decade for carrying out mainly so-called “laboratory astrophysics experiments”. During this workshop, the participants obtained an overview of the science produced so far and the technical difficulties that have been solved.

### **Perspectives & Projects | Specifications & Roadmap**

A significant international effort has been carried out to develop experiments coupling high magnetic fields and high power lasers. Following each presentation, the participants discussed about possible improvements of the existing experiments or developments of new experiments. The perspectives toward much higher magnetic fields (i.e, up to 60 T) and their adaptation to the high repetition rate of new laser facilities (to reach around one pulse per minute) have also been discussed. EMFL can provide its know-how, in particular on non-destructive pulsed magnets with large magnetized volume and wide apertures and their associated power sources. A strong demand exists for such devices adapted to power-laser environments that can provide high magnetic fields on a well-controlled way in terms of time stability, homogeneity and strength. The roadmap will be defined for European infrastructures interested in collaborating with the EMFL, but this discussion and the contributions coming from all over the world collected during this workshop will benefit the whole community.

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## Program of the workshop:

	Monday 19/12		Tuesday 20/12
	Session "Collisionless shocks"		Session "Instabilities"
9:00-9:30	Takanobu Amano, Electron injection at high-Mach number collisionless oblique shocks	9:00-9:30	Virginia Bresci, Saturation of the asymmetric current filamentation instability under conditions relevant to relativistic shock precursors
9:30-10:00	Damiano Caprioli, The microphysics of collisionless shocks	9:30-10:00	Maxence Gauthier, Time-resolved X-ray imaging of Weibel-like instabilities in high-intensity laser plasma interactions
10:00-10:30	A. Grassi, Energy partition in collisionless shocks, including both new NIF experiments and simulations analysis	10:00-10:30	Alexis Marret, Magnetic field amplification by the non-resonant cosmic rays streaming instability
break 30'		break 30'	
11:00-11:30	Arno Vanthieghem, Electron heating within shocks dominated by the Weibel instability		Session "Instabilities"
	Session "Astrophysically-relevant plasmas"	11:00-11:30	Taiki Jikei, The role of finite background magnetic field for Weibel instability at collisionless shocks
11:30-12:00	B. Albertazzi, Interplay between plasmas and Magnetic field experiments focused on accretion and supernovae	11:30-12:00	Fabio Bacchini, Kinetic shearing-box simulations of the magnetorotational instability in 3D
12:00-12:30	Weipeng Yao, Laboratory stochastic particle acceleration in double-jet collision via magnetic Rayleigh-Taylor instability	12:00-12:30	Yasu Kuramitsu, Nonlinear evolution of the Weibel and filament instabilities in laser produced plasmas under the influence of an ambient magnetic field
12:30-13:00	Sophia Malko, Observation of Rayleigh-Taylor instability in axially magnetically collimated plasma jets in the laboratory	12:30-13:00	Chun-Sung Jao, Preliminary study for the laboratory experiment of non-resonant streaming instability
lunch		lunch	
	Session "Implosions and shocks"		Session "UHI plasmas"
14:45-15:00	G. Rikken, Introduction by the ISABEL coordinator of the Relations with EU Research Infrastructures	14:00-14:30	Brandon Russell, Generation and measurement of magnetic fields in ultra-intense laser-solid interactions
15:00-15:30	Roland Duclos/Olivier MICHEL, A non-local electron transport model in the diffusion scaling of Magneto-Hydrodynamics	14:30-15:00	Jens von der Linden, Magnetic manipulation techniques for relativistic electron-positron pair plasma including collimation, focusing, and mirror trapping
15:30-16:00	C. Niemann, Measurements of collisionless coupling between explosive debris plasma and a magnetized background	15:00-15:30	Ryan Peterson, Magnetic Cavitation in Laser-Driven Electron Beams
break 30'			
16:30-17:00	JJ Santos, Studies of extended-MHD effects and confinement properties of magnetized cylindrical implosions		Apollon visit
17:00-17:30	C. A. Walsh, Magnetized ICF Implosions: Scaling of temperature and yield enhancement		Apollon visit
17:30-18:00	Hong Sio, Magnetized indirect-drive inertial confinement fusion at the National Ignition Facility		Apollon visit
18:00-18:30	J. Beard, Generation of 60 T fields compatible with laser-plasma experiment		Apollon visit
	Wednesday 21/12		
	Session "Turbulence"		
9:00-9:30	Archie Bott, Studying the fluctuation dynamo and magnetized turbulence with the TDYNO laser-plasma experiments		
9:30-10:00	Graeme D Sutcliffe, Experiments studying magnetic field generation and saturation mechanisms in plasmas at the OMEGA laser		
10:00-10:30	Norbert Magyar, MHD turbulence generation in inhomogeneous plasmas		
break 30'			
	Session "MR"		
11:00-11:30	R. Smets, Laboratory investigation of reconnection weakened by a guide-field		
11:30-12:00	Kentaro Sakai, Magnetic reconnection driven by electron dynamics in laser produced plasmas		
12:00-12:30	A. Sladkov, Numerical study of magnetic reconnection in laser-produced high-aspect ratio plasmas		
12:30-13:00	Lee Suttle, Investigating non-thermal particle heating in collisional reconnection experiments		
lunch			
	Session "Laser-driven plasmas"		
14:30-15:00	Yuji Fukuda, Magnetic field generation and particle acceleration in laser-cluster plasmas		
15:00-15:30	Bertrand ETCHESSAHAR, Design of a magnetization system for LMJ-PETAL		
15:30-16:00	J. Fuchs, Dynamics of nanosecond laser pulse propagation and of associated instabilities in a magnetized underdense plasma		
break 30'			
	Session "Astrophysically-relevant plasmas"		
16:30-17:00	Salvatore Orlando, Role of magnetic field in the evolution of supernova remnants		
17:00-17:30	Simon Bolaños, Laboratory study of the initial stages of quasi-parallel collisionless shocks relevant to supernova remnants		
17:30-18:00	George Wong, Addressing the Uncertainties in Global Black Hole Accretion Simulations		

## Speakers affiliations

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 J. von der Linden (IPP)  
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## Report on the Workshop on *The Combination of High Magnetic Fields and Free Electron Lasers - Nijmegen, the Netherlands - June 14-15, 2023*

Following the yearly EMFL User Meeting held on June 13-14, 2023 in Nijmegen, this workshop was organized by HFML-FELIX at the Faculty of Science of Radboud University in Nijmegen during two half days on Wednesday afternoon, June 14 and Thursday morning, June 15. It was financially supported by the European project ISABEL and the Dutch Research Council NWO.

This workshop gathered scientific and technical experts interested in experiments using the combination of high magnetic fields and THz radiation with three major objectives:

- (1) inform the community on recently performed combination experiments and on their scientific significance
- (2) provide an overview of the general possibilities of combination experiments including both pulsed and continuous magnetic fields, discuss their technical challenges and gather feedback for future user wishes
- (3) Prepare a future scientific and technological vision for the combination of high magnetic fields and THz free-electron lasers.

The meeting was attended by about 50 participants and consisted of six invited contributions on scientific and instrumental aspects, details of the programme are given below.

The talks were complemented by an informal visit to HFML-FELIX, a user facility offering both continuous high-field magnets up to 38 T and infrared/THz free-electron lasers from 0.2 to 100 THz as well as the combination thereof. We also allowed ample time for discussions in small groups during the workshop as well as during a common dinner organised on Wednesday evening.

## Workshop summary

The workshop was preceded by the final talk of the HFML-FELIX / EMFL user meeting given by Ben Murdin (University of Surrey, UK), who addressed the combination of high magnetic fields and THz radiation and presented some recent research examples done at the HFML/FELIX combination. In the workshop itself, seven speakers re-stressed how such a unique combination provides the scientific community with new research possibilities.

The scientific session started with a talk entitled “Shaken,not stirred: the FELIX recipe for ultrafast magnetization reversal” given by Andrei Kirilyuk from HFML-FELIX Nijmegen followed by a talk by Sergei Zvyagin from HLD-HZDR in Dresden. Using some recent examples, Andrei stressed the general importance of the combination of THz experiments and high magnetic fields (both pulsed and continuous).

After a short break, three short presentations by Dima Afanasiev from Radboud University in Nijmegen (Light-driven phonomagnetism), Maurice Bal from HFML-FELIX (THz conductivity and resistively detected cyclotron resonances in InSb) and Steffen Wiedmann from HFML-FELIX (Quantum materials @ HFML: state-of-the-art and future prospects). In particular, Maurice’s talk illustrated nicely how the HFML-FELIX combination can be used to access a new regime in electronic transport and to characterize the electronic properties of relevant materials using both THz radiation and high magnetic fields.

On Thursday morning, the workshop continued with a talk by Michael Klop, FEL beamline scientist of the ELBE radiation source at HZDR in Dresden. In particular, Michael explained the working principle of ELBE and illustrated how this source can be used for driving non-equilibrium non- linear dynamics. The second talk in the morning session was given by Peter Christianen from HFML-FELIX, who reviewed several recent experiments using the HFML-FELIX combination.

The workshop concluded with a discussion on the possibilities of the existing combination sites (HFML-FELIX in Nijmegen and HLD-FELBE in Dresden) and possible future possibilities experiments and collaborations. Specifically, the following points were addressed:

- 1) The possibility to use radial-access and spilt-coil magnets for, e.g. two-colour pump-probe experiments. Though such specialised magnets may be highly desirable for specific experiments, it was emphasised that the development of such magnets would reduce the maximum field (typically by 1/3). Indeed, some experiments may also be doable with a vertical access magnets in combination with waveguides and mirrors.
- 2) An important feature of free electron lasers is the possibility to perform time resolved experiments and to access, for example, the charge-carrier dynamics in semiconductors in high magnetic fields.
- 3) The high-intensity of free-electron lasers can also be exploited to perform non-linear spectroscopy in high magnetic fields, where the response of the system strongly depends on the incident light intensity. This can, for example, lead to the creation of higher harmonics as indeed nicely illustrated in Michael Klop’s talk.

Moreover, high-power radiation can also be used to actually change the state of matter by, e.g., creating magnetic excitations or destroying Cooper pairs in superconductors.

- 4) Even when only interested in linear spectroscopy the high-power lasers can be used to perform experiments in nanostructures, where the absolute phonon flux has to be sufficient to provide a measurable signal.
- 5) The high-field EPR community interested in biological systems may be an important user community to get interested in combination experiments using both high fields and intense infrared radiation. An important aspect for this community, as well as for any other user, is that the combination experiments become easily accessible by actively stimulating collaborations and secondments (e.g., via ISABEL or follow-up projects)
- 6) A well-defined chain of experiments towards high-field / THz combination experiments by running a sample through different levels should be established:
  - Zero-field experiments with THz only or high-field experiments without THz
  - Low-field preliminary experiments using superconducting magnets
  - Time-resolved experiments (if desired)
 The establishment of such a generalised test lab should allow the development of new experiments even before a proposal is submitted.
- 7) Finally, it is certainly worth mentioning that the discussion also included the idea of using future 32-T and 40-T all-superconducting magnets designed within the SuperEMFL project for combination experiments with free-electron lasers. Specifically, it was concluded, that the design of these all-superconducting magnets with a central vertical bore will make it possible to transfer existing experimental setups for DC Bitter magnets to a future all-superconducting magnet.

In conclusion, the workshop has successfully contributed to inform interested users on the possibilities of the combination of high magnetic fields and free electron lasers, it has stimulated a discussion on the possibilities and has laid the foundation for a future scientific and technological vision for the combination of high magnetic fields and THz free-electron lasers.

### Organizing committee

Jos Omens, HFML-FELIX, RU Nijmegen

Steffen Wiedmann, HFML-FELIX, RU Nijmegen

Uli Zeitler, HFML-FELIX, RU Nijmegen

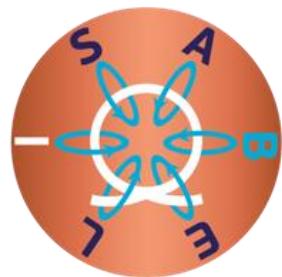
## Workshop programme

### Wednesday 14th June 2023

Chair:	Peter Christianen	HG00.304
11:30 – 12:20	Plenary talk: <b>Ben Murdin</b> , University of Surrey <i>Far-infrared, non-linear Ramsey spectroscopy applied to donors in silicon at high magnetic field</i>	
12:30	Lunch	
14:00 - 14:30	<b>Britta Redlich</b> (HFML-FELIX) <i>Welcome and general introduction to the workshop</i>	
14:30 - 15:00	<b>Andrei Kiriliouk</b> (HFML-FELIX) <i>Shaken, not stirred: the FELIX recipe for ultrafast magnetization reversal</i>	
15:00 - 15:30	<b>Sergei Zvyagin</b> (HZDR) <i>THz resonance spectroscopy in high magnetic fields</i>	
15:30	Coffee	
16:00 - 16:20	<b>Dima Afanasiev</b> (IMM, Radboud University) <i>Light-driven phonomagnetism</i>	
16.20 - 16 :40	<b>Maurice Bal</b> (HFML-FELIX) <i>THz conductivity and resistively detected cyclotron resonances in InSb</i>	
16.40 – 17:00	<b>Steffen Wiedmann</b> (HFML-FELIX) <i>Quantum materials @ HFML: state-of-the-art and future prospects</i>	
17.00	Lab tours & informal discussion	
18.00	Dinner	

### Thursday 15th June 2023

Chair:	Steffen Wiedmann	HG00.539
09:00 – 09:30	<b>Michael Klopff</b> (HZDR) <i>The ELBE THz sources – Tunable coherent THz for driving non-equilibrium non-linear dynamics</i>	
09:30 – 10:00	<b>Peter Christianen</b> (HFML-FELIX) <i>High Magnetic Field THz Spectroscopy in Semiconductors</i>	
10:00 – 11:30	Coffee & poster session	
11:30 – 12:30	Plenary discussion on the combination of high magnetic fields and free electron lasers: experimental wishes and possibilities Discussion leader: Ben Murdin, University of Surrey	



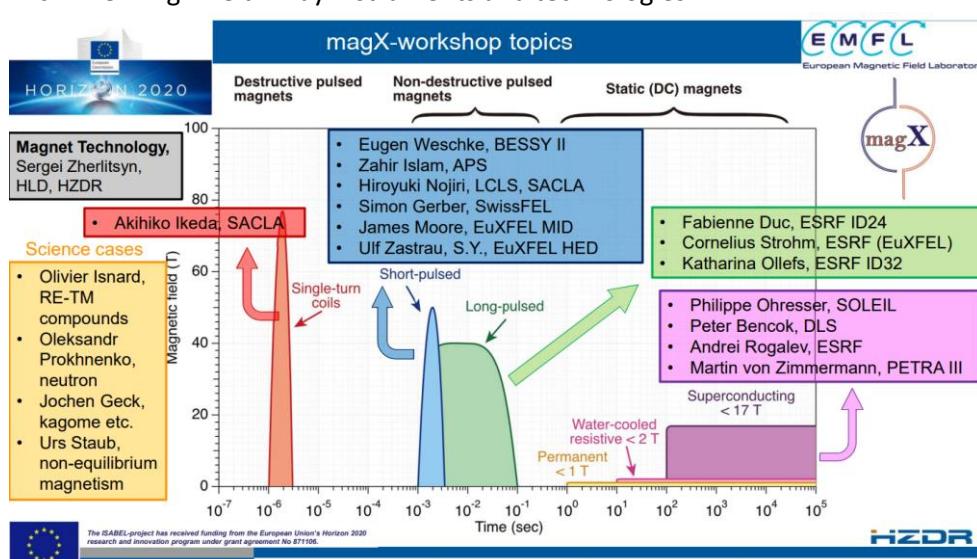
## Report on the Workshop “Frontiers of Synchrotron and XFEL Research at High Magnetic Fields” (magX)

HZDR, Dresden, Germany - November 8-10, 2023

This workshop was organized by staff of the Helmholtz-Zentrum Dresden – Rossendorf (HZDR), Shingo Yamamoto (Dresden High Magnetic Field Laboratory, HLD) as well as of Lakshmi Bhaskaran (Department for Research Programmes & International Projects) supported by other staff members at the HLD. The magX workshop was organized in the frame of the project ISABEL and, by that, was financially supported by the European Union, under Grant Agreement n°871106.

The magX program committee, Fabienne Duc (LNCMI-CNRS, France), Florence Lecouturier (LNCMI-CNRS, France), Charles Simon (LNCMI-CNRS, France), Geert Rikken (LNCMI-CNRS, France), Uli Zeitler (HFML, The Netherlands), Shingo Yamamoto (HLD, HZDR, Germany) and Joachim Wosnitza (HLD, HZDR, Germany), elaborated a scientific program that covered the following topics:

- Trends, challenges, and future perspectives in the field,
- X-ray scattering and spectroscopy at high magnetic fields,
- New sample materials perspectives,
- New high-field X-ray instruments and technologies.



The selection of the contributions also aimed at presenting the comprehensive state of the art of x-ray experiments both performed at cyclotrons and XFELs in a variety of high-field magnets ranging from superconducting, nondestructive pulsed to even semi-destructive  $\mu$ s-pulsed coils.

By that, the workshop provided an interactive forum for scientists for presenting and discussing their latest research results obtained using X-ray radiation sources and high magnetic fields. The workshop also provided an excellent opportunity for scientists and engineers to discuss the current state of the art of instrumentation and to explore possible collaborations between participants and institutions. By that, the workshop gathered scientific and technical experts of universities as well as X-ray and high-field facilities with the aim of identifying the needs of the X-ray photon community to make use of high-field sample environment.

The workshop attracted 46 registered participants, coming mostly from Europe. However, there were even onsite participants coming from Japan and the USA. The workshop was structured as a three-day lunch-to-lunch event with eight sessions of each two to four talks, all-in-all comprising 20 invited contributions on scientific and instrumental aspects, see ***scientific program*** described below. Ample time was reserved and indeed widely used by participants for discussions after each presentation.

As workshop venue, the lecture hall and conference premises of the HZDR were used. The workshop was held as an in-person event with two exceptions of participants from overseas giving remote talks.



Workshop photo of magX participants, taken onsite at Nov. 9, 2023.

## Scientific Program of magX workshop

In addition to the following scientific program, the workshop organizers have prepared an abstract booklet that contains the names and affiliations of all participants and asked all speakers to submit copies of their presentations for making them sustainably accessible to registered users and staff of the EMFL. For rounding up the workshop the organizers have also given participants the opportunity to visit the onsite laboratories of the Dresden High Magnetic Field Laboratory (HLD) at the HZDR.

# Program

## Wednesday, November 8 2023

**12:30 - 13:30** Welcome lunch and reception at the Lecture hall

**13:40 - 13:50** Welcome  
Thomas Cowan (HZDR, Germany)

**13:50 - 14:00** Introduction of the workshop  
Shingo Yamamoto (HLD-HZDR, Germany)

**14:00 - 14:45** X-ray Scattering in High Magnetic Fields-Application for CDW Transitions in Superconductors and in Semimetal  
Hiroyuki Nojiri (Tohoku University, Japan), remote

**14:45 - 15:30** Investigation of magnetisation processes in rare-earth transition metal compounds  
Olivier Isnard (University Grenoble Alpes, France)

**15:30 - 16:00** Coffee Break

**16:00 - 16:45** Neutron scattering at the 26 T HFM/EXED facility and opportunities for X-rays  
Oleksandr Prokhnenco (Helmholtz-Zentrum Berlin, Germany)

**16:45 - 17:30** Pulsed magnetic fields for science  
Sergei Zherlitsyn (HLD-HZDR, Germany)

**17:30 - 18:00** HLD Facility Visit  
coordinated by Thomas Herrmannsdörfer and Yurii Skourski (HLD-HZDR, Germany)

**18:15 -** Light dinner at HZDR

## Thursday, November 9 2023

**9:00 - 9:45** Sub-Kelvin for X-rays measurement: Development of a specific dilution fridge on the DEIMOS beamline @ Synchrotron Soleil  
Philippe Ohresser (SOLEIL, France), remote

**9:45 - 10:30** 14 T Magnet for X-ray magnetic circular dichroism  
Peter Bencok (Diamond Light Source, UK)

**10:30 - 10:45** Coffee Break

**10:45 - 11:30** X-ray magnetic circular dichroism under high magnetic field  
Andrei Rogalev (ESRF, France)

**11:30 - 12:15** Pulsed Magnetic Fields and Synchrotron Soft X-Rays  
Eugen Weschke (Helmholtz-Zentrum Berlin, Germany)

**12:15 - 13:30** Lunch Break

## Thursday, November 9 2023

<b>13:30 - 14:15</b>	<b>Road to X-ray science at 100 T</b> Akihiko Ikeda (University of Electro-Communications, Japan)
<b>14:15 - 15:00</b>	<b>Exploring quantum matter under extreme conditions at the SwissFEL Cristallina endstation</b> Simon Gerber (Paul Scherrer Institut, Switzerland)
<b>15:00 - 15:45</b>	<b>Quantum materials in high magnetic fields: Experimental challenges</b> Jochen Geck (TU Dresden, Germany)

<b>15:45 - 16:05</b>	<b>Coffee Break</b>
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<b>16:05 - 16:50</b>	<b>Non-equilibrium magnetism probed by X-Rays</b> Urs Staub (Paul Scherrer Institut, Switzerland)
<b>16:50 - 17:35</b>	<b>High energy x-ray diffraction under high magnetic field at DESY</b> Martin von Zimmermann (DESY, Germany)
<b>17:35 - 18:20</b>	<b>Evolving multi-modal research in high magnetic field with diffraction and diffraction-contrast imaging at APS-<math>\text{U}</math></b> Zahir Islam (Argonne National Laboratory, US)

<b>19:00 - 21:00</b>	<b>Dinner</b>
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## Friday, November 10 2023

<b>9:00 - 9:30</b>	<b>X-ray absorption spectroscopy in high pulsed magnetic fields</b> Fabienne Duc (LNCMI-CNRS, France)
<b>9:30 - 9:50</b>	<b>The HED-HIBEF instrument at the European XFEL</b> Ulf Zastrau (European XFEL GmbH, Germany)
<b>9:50 - 10:20</b>	<b>X-ray spectroscopy in multi-extreme conditions of temperature, pressure and pulsed high magnetic fields</b> Cornelius Strohm (DESY, Germany)
<b>10:20 - 10:50</b>	<b>Pulsed magnetic fields system for HIBEF at the European XFEL facility</b> Shingo Yamamoto (HLD-HZDR, Germany)

<b>10:50 - 11:00</b>	<b>Coffee Break</b>
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<b>11:00 - 11:30</b>	<b>A miniature split-pair coil sample environment at the Materials and Imaging Dynamics instrument</b> James Moore (European XFEL GmbH, Germany)
<b>11:30 - 12:00</b>	<b>PUMA – ‘PULsed high MAGnetic fields for new functional magnetic materials’</b> Katharina Ollefs (Universität Duisburg-Essen, Germany)

<b>12:00 - 12:05</b>	<b>Closing remarks</b>
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<b>12:05 -</b>	<b>Lunch to go</b>
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