

# NEWLY ARRIVED!



# Newsletter

# 23

MLZ is a cooperation between:

### The Heinz Maier-Leibnitz Zentrum (MLZ):

The Heinz Maier-Leibnitz Zentrum is a leading centre for cutting-edge research with neutrons and positrons. Operating as a user facility, the MLZ offers a unique suite of high-performance neutron scattering instruments. This cooperation involves the Technische Universität München, the Forschungszentrum Jülich and the Helmholtz-Zentrum Geesthacht. The MLZ is funded by the German Federal Ministry of Education and Research, together with the Bavarian State Ministry of Science and the Arts and the partners of the cooperation.

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# meeting meeting, user meeting!

An editorial  
by

Getting in contact with its customers is key for any company. This holds even more for the MLZ as our customers – our users – are not only our *raison d'être*, they are our colleagues and friends. That is why we organised user meetings in the past and we are highly motivated to revive this tradition in a new format.

We know that the format by itself – to have a first half-day with scientific exchange and mini-symposia and a second half-day with information what is going on at the MLZ and to show some scientific highlights of our users – was not invented by us. However, it seems to be attractive as it gives ample amount of time to talk and have a nice dinner altogether. The date to implement our user meeting at the beginning of December coincides with the tradition from Berlin, whose successful facility has unfortunately to be shut down by the end of this year. In this sense, we aim to take over the tradition of a family meeting at the end of every year, starting in 2019.

On the one hand, we are well aware that the numbers of meetings or neutron events are constantly increasing. As a recent example, one could mention the newly established joint European user meeting of the ILL and the ESS. This exerts severe pressure to coordinate the dates for our national, European and international conferences on neutron scattering, the DN, ECNS and ICNS, respectively. We are lucky that the family of neutron researches is a big one and that it is based on German scientists to a significant extend, however we are not sure if you have the time for more than one family meeting per year. On the other hand, this might not be true, so we are happy to receive any feedback, either directly to the staff of the MLZ or via our User Committee.

Anyhow, see you next time!



*Jürgen Neuhaus*  
(FRM II Deputy Scientific Director)

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## USER OFFICE

## New projects in the ErUM Pro programme: Successful round for research with neutrons and positions

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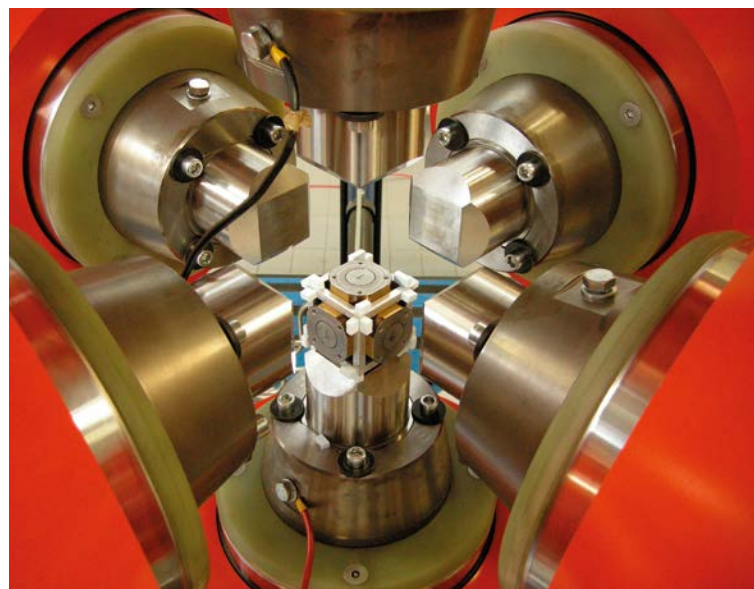
Building new and upgrading operating instruments is a continuous process established at the MLZ since the start of user operation. A significant part of this endeavour is realised by research and development projects of

German universities supported by the Federal Ministry of Education and Research (BMBF) via the so called ErUM-programme – successor of the very successful Collaborative Research (Verbundforschung). The recent call asked for instrumental developments for the period 2019-2022.

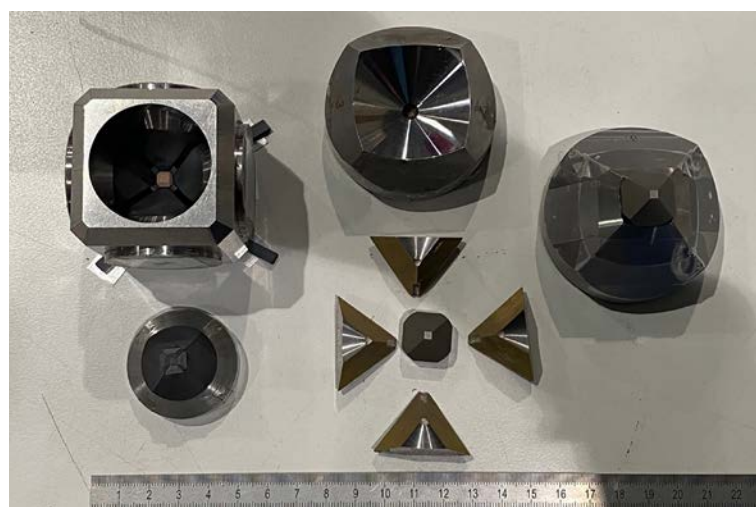
In total, 16 projects in relation to the MLZ have been successful, equivalent to a total funding of approximately 13 Mio €. Among the successful proposals are completion projects for new instruments, upgrades and provision of add-on options at running instruments in user operation, conceptual studies as well as the design and set-up of specialised sample environments – to the overall benefit of the MLZ instrument suite.

### Instruments

The new time-of-flight diffractometer **SAPHiR** is dedicated to perform in-situ neutron diffraction and high resolution neutron radiography at pressures up to 15 GPa and at temperatures above 2000°C. The instrument was constructed by the Bavarian Research Institute of Experimental Geochemistry and Geophysics (BGI) of the University of Bayreuth with the aim to investigate geological samples under high pressure and high temperature. All major components, including the multi-anvil press, choppers, neutron guides, and detectors had been built and are ready for installation – urgently waiting for neutrons in the Neutron Guide Hall East. Within the duration of the current project, installation and commissioning will be accomplished and first scientific experiments are planned. Another challenging part is the optimisation of the anvils to increase the available pressures up to 25 GPa also for 'large' sample volumes (up to 20 mm<sup>3</sup>).



Above: The multi anvil press at SAPHiR. Below: Test of new materials and new anvil geometries to achieve sample pressures >23 GPa. (left) Sintered diamond (SD) anvils with a 2.5 mm truncation, (center and right) New anvil prototype for minimizing tensional stresses in the pressure tip.



**KOMPASS** – operated by the University of Cologne and Technical University of Munich – is a fully polarised cold three axes spectrometer, located in the Neutron Guide Hall West. The instrument has already seen first neutrons and commissioning of KOMPASS has started. The polarising units have been tested successfully with neutrons in diffraction mode. The next steps are the installation and commissioning of the inelastic part of the spectrometer, full characterisation of the focussing options as well as the optimisation of the polarisation quality with special emphasis to the three dimensional polarisation analysis.

The time-of-flight diffractometer **POWTEX** is awaiting installation in the Neutron Guide Hall East, with all major components ready. The instrument is built by the Institute for Solid-State and Quantum Chemistry, RWTH Aachen, in close cooperation with the Forschungszentrum Jülich GmbH and the Geowissenschaftliches Zentrum, Georg-August-Universität Göttingen. Besides the installation and commissioning of the instrument, the current project period will also focus on the development of the dedicated TOF-diffraction software, i.e. the data treatment and Rietveld refinement of multidimensional angle and wavelength dispersive diffraction data.

## Upgrades and Methods

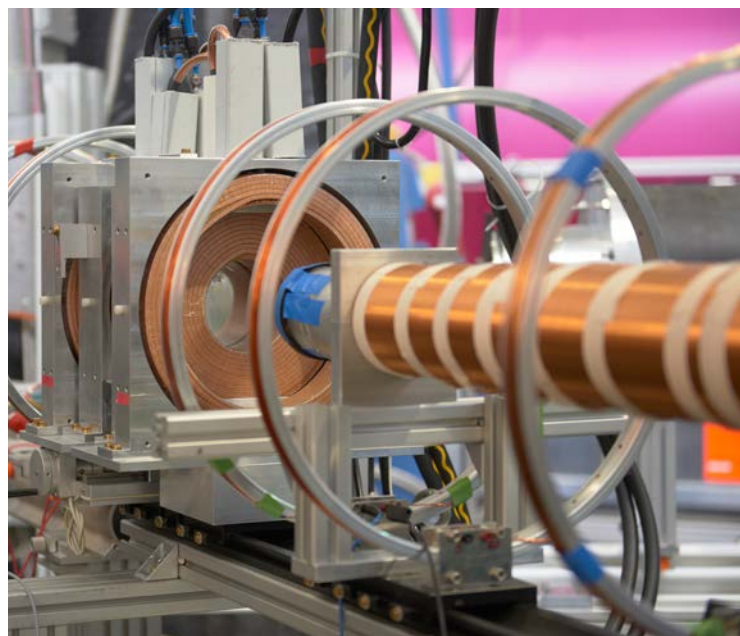
Further projects are focussed on the development of dedicated add-ons to existing instruments. For PANDA, the well established cold three axis spectrometer at MLZ, the completion of the multi-analyser unit **BAMBUS** is supported. Developed by the Institute of solid state physics at the TU Dresden, BAMBUS is foreseen as an optional analyser/ detector choice for PANDA, where the multi-analyser system records neutrons at multiple scattering angles and five different energy transfers. The scientific systems of interest cover quantum and low dimensional magnetism often featuring distributed scattering intensities in Q-space. After the successful tests of prototypes, the final multi-analyser hardware is being built and expected to be ready in the next couple of months. The tasks within the current project include the commissioning of BAMBUS and, most important, develop suitable – meaning: user friendly – software for visualisation and analysis, with special emphasis on the handling of the resolution corrections.

The new powder diffractometer **ErwiN** will focus on pertinent questions arising in the fields of energy research – especially for parametric and in-operando studies. ErwiN is constructed by the Institute for Applied Materials, Energy Storage Systems at the KIT. The instrument shares the beam port with the single crystal instrument RESI and only measurements at one of the two instruments are possible at any moment in time. With its high flux and the large detector area, ErwiN complements the thermal diffractometer suite

at MLZ. The construction of all major components is almost completed and installation in the Experimental Hall and commissioning with neutrons is anticipated.

The project **NeutroSense** will develop a new detector system at the imaging beamline ANTARES that will employ single event mode data acquisition combined with new software development to achieve ultra high spatial resolution of  $\sim 1 \mu\text{m}$ , needed, e.g. to study the water management in fuel cells. The project is a joint enterprise between the Department of Microsystems Engineering (IMTEK), Universität Freiburg and the FRM II, Technical University of Munich (TUM).

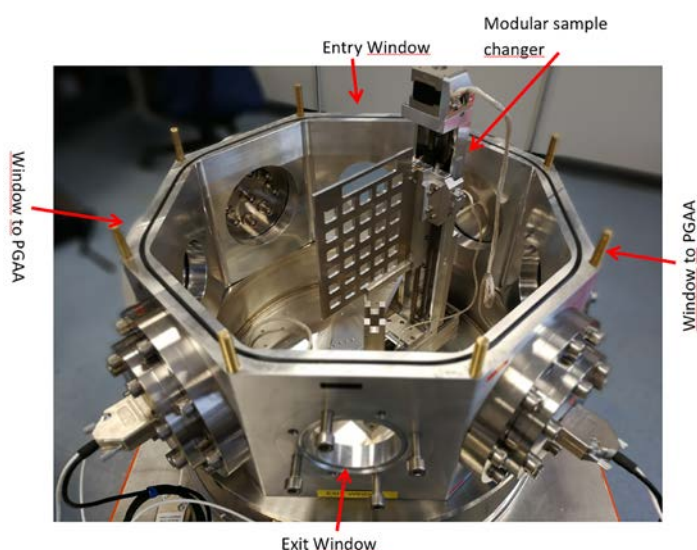
At RESEDA, the group of C. Pfeleiderer at the Physics Department of TUM is going to develop an extension for high resolution inelastic SANS measurements. The project **MIASANS** will upgrade the MIEZE option at RESEDA with superconducting spin flip coils (up to 8 MHz) and a dedicated small angle detector tank. Additionally, improvement in the neutron optics of the primary beam path will enhance the performance at larger angles as well while keeping the current flexibility of the instrument. With these additions, RESEDA will have access to relaxations at low Q-values in depolarizing conditions, such as e.g. spin waves in Fe.



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The instrument Reseda will get an upgrade of the small angle capabilities with new superconducting spin flip coils, and the add-on of small angle options for the primary and secondary spectrometer arm.

MIRA will also increase its capabilities offered by the MIEZE technique: The project **MIEZEFOC** under the lead of P. Böni, Physics Department of TUM, will combine focussing optics with a longitudinal MIEZE set-up as add-on for the instrument, offering again access to a large dynamic range using a spin echo technique. The modular and self-contained built-up makes this MIEZE Box potentially transferable to other instruments as well.



The sample chamber at PGAA used for neutron depth profiling (N4DP). Better depth resolution as well as the option for time resolved kinetic studies are to be expected in the coming years.

Another instrumental upgrade is foreseen with the project **N4DP** at the PGAA, aiming at improving the capabilities for time resolved isotope tracking with neutron depth profiling. Of special interest are strong neutron absorbing materials like boron or lithium as function of penetration depth e.g. for the characterisation of Li-ion battery cathodes. The project is a collaboration of the Physics Department and the FRM II (both TUM). The method has already been successfully employed with high resolution depth profiles up to 5 nm of isotopes such as  $^6\text{Li}$ ,  $^{10}\text{B}$ ,  $^{14}\text{N}$ ,  $^{35}\text{Cl}$ . The planned upgrade will improve the background by installation of a new detector as well as a background chopper, in addition to the optimisation of the incoming neutron optics.

The positron source NEPOMUC and the associated instrumentation receives a new measurement option by the transfer of the – at the moment still – laboratory based **scanning positron microscope** to the Experi-

mental Hall. The project will be realised by the Institute for Applied Physics and Metrology at the Universität der Bundeswehr München and Physics Department of TUM which jointly operate the NEPOMUC facility. The scanning positron microscope will focus the intense positron beam of NEPOMUC down to 1  $\mu\text{m}$  in size, yielding to a high spatial resolution as well as to a high time resolution of the positron lifetime measurement. Features that can be used e.g. to map defect concentrations in functional materials with unprecedented precision. Additionally, the implementation of a triggered positron lifetime experiment with e.g. a pulsed laser set-up will enable positron lifetime experiments correlated with external stimuli, such as under light illumination under the application of electric fields.



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Interface unit to connect the positron scanning microscope to the NEPOMUC source, generating a high brilliance pulsed beam suitable for scanning microscopy applications.

In terms of new instrumentation and method development, a conception study for a **new indirect crystal spectrometer** also received funding. The underlying idea relies on a very compact secondary crystal spectrometer, yet covering a large part of the solid angle ("Mushroom concept"). A conceptual design for both the primary as well as the secondary spectrometer shall be developed to evaluate the potential of such an instrument.

## Sample Environment

The project **RAPtOr** is dedicated to the installation and commissioning of a new control system for the already existing robot at STRESS-SPEC. Together with the Friedrich-Alexander-University in Erlangen, an optical control feedback loop will be implemented to ensure high absolute precision and reproducible placement of the specimens (better than 50  $\mu\text{m}$ ) by the robot in the beam. This is especially pertinent for the investigation of oddly shaped samples as it is commonly the case for components produced by additive manufacturing. With the increasing importance of this production method, the associated materials' properties such as induced textures or internal stresses are of great interest. In the long term, it is foreseen that the robot will become the main sample changer for STRESS-SPEC.



The robot at STRESS-SPEC holding a motor block in position, the part probed by the neutrons is marked by the red laser spot. With the new control system for the robot, the absolute precision of the positioning system will be increased to about 50  $\mu\text{m}$ .

Also related to the area of materials science, the project **HiMAT** aims to implement and provide the new testing rig for the investigation of industry relevant high temperature alloys. The testing rig offers the application of tension or compression at temperatures up to 1200°C, i.e. enabling in-situ neutron scattering experiments on bulk samples of advanced high temperature alloys under application of the relevant working conditions.

Another sample environment development project, **HPneutron**, lead by the RWTH Aachen, is dedicated to high pressure devices to be used at several diffraction and spectroscopy beamlines. New cell designs for pressures up to 5 GPa will be implemented that are both suitable for requirements at the various beamlines and at the same time will fit into the existing infrastructures such as cryostats and magnets.

The project **NHSM** was granted to evaluate feasibility studies for a new 12 T horizontal magnet and to specify and optimise the design parameters, especially concerning the field compensation. A first conceptual design had already shown the possibility to have a dry (closed cycle) system up to 12 T, with a field of view of +/-10 deg.

Within the project **NeutIR**, an infrared absorption spectrometer set-up will be installed to be used at KWS-2, for simultaneous measurement of the same sample during the neutron experiment. The availability of complementary methods is especially relevant in the areas of life sciences and medicine, e.g. to address the structure-function relationship in proteins.

*W. Lohstroh (FRM II)*



## Development of a new high visibility neutron grating interferometer at ANTARES

Neutron grating interferometry (nGI) is an advanced neutron imaging technique allowing to simultaneously recover information on the absorption, refraction and ultra-small-angle scattering (USANS) of neutrons inside a sample. Especially the signal generated by USANS, called dark-field image (DFI), has generated high interest as it allows to indirectly resolve material structures in a range from 100 nm to 20  $\mu\text{m}$ , thus complementing the spatial resolution achieved in classical neutron imaging. Remarkably, scattering caused by magnetic domains can be tracked, enabling the local evaluation of magnetic properties in bulk materials.

A key attribute of an nGI-set-up is the achieved interferometric contrast (visibility), as this attribute is intimately linked to the signal-to-noise-ratio of the acquired data. An nGI-set-up in Talbot-Lau geometry consists of two absorber gratings (G0 and G2) and one phase grating (G1). These gratings need to fulfill certain conditions with respect to their periodicity as well as the inter-grating distances. Combined with the properties to be analysed (USANS) this leads to grating periods in the micrometer range.

It has been shown that for high visibility the quality of the absorption gratings, especially G2, needs to be improved with respect to their absorptivity and shape [1]. Ideally, a binary grating profile is achieved. The current standard of producing absorber gratings, sidewall-evaporation of Gd on an etched silicon grating

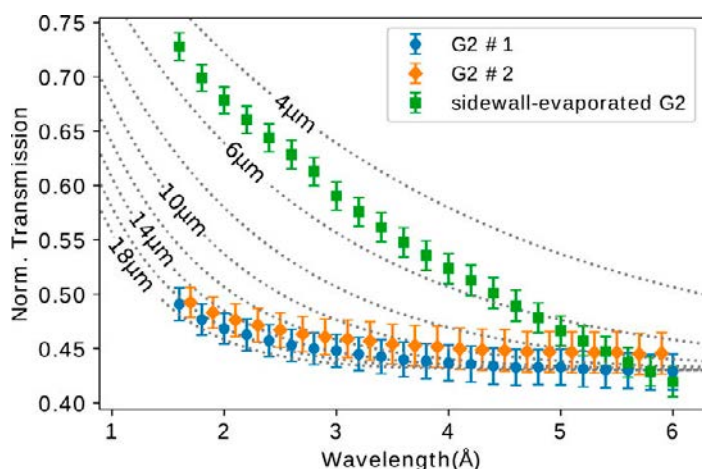


Fig. 1: Transmission data for two newly fabricated G2 gratings (duty cycle: 0.43) (blue and orange markers) compared with the sidewall Gd-evaporated G2 previously used (duty cycle: 0.56) (green markers). The dotted gray lines denote the simulated transmission of neutrons through a binary absorbing grating (duty cycle: 0.43) with different Gd heights. Taken from [2].

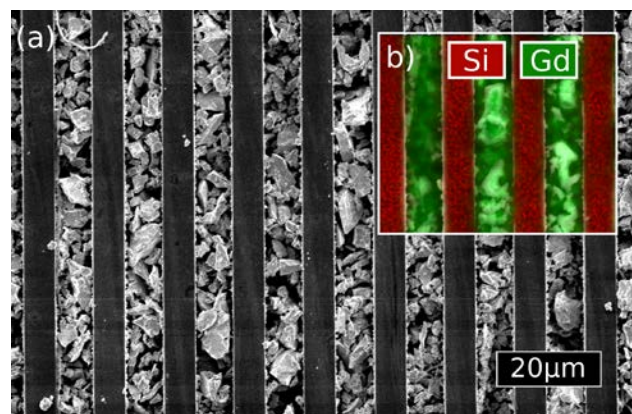


Fig. 2: (a) SEM image of the Gd-particle filled G2 grating. (b) Energy-dispersive X-ray fluorescence (EDX) mapping shows high Gd concentration in the grating trenches. Taken from [2].

structure is not able to deliver the necessary Gd height profile. Especially, grating G2 suffers from these problems the most, as it has typically the smallest period. In particular, at short neutron wavelengths (1.6  $\text{\AA}$  to 3  $\text{\AA}$ ) the absorption performance of the gratings suffers. (fig. 1)

Hence, for the new interferometer set-up built at ANTARES, a new manufacturing process for the absorber gratings was introduced, in which the necessary grating structure was etched in a silicon wafer and afterwards etched grooves were filled with Gd micro-particles [2]. In fig. 2, a SEM image of the surface of a Gd-particle filled G2 grating is shown.

As shown in fig. 1, the new production technique significantly improves the absorption performance of G2 in the accessible wavelength range (1.6  $\text{\AA}$  to 6  $\text{\AA}$ ) at ANTARES. Due to the improved gratings, the upgraded interferometer setup reaches a maximum visibility of 74 % over the full field of view of the detector (71 mm x 76 mm). This is the highest visibility yet achieved with a neutron grating interferometer.

*T. Neuwirth, A. Backs, M. Schulz (FRM II)  
A. Gutschin (TUM)*

### Read more

[1] R. Harti et al., Rev. Sci. Instrum. 88.10 (2017), p. 103704.

[2] A. Gutschin et al., Rev. Sci. Instrum. 89.10 (2018), p. 103702.

## Automated data treatment for “Soft Matter” neutron reflectivity at MARIA

Based on the high flux and recent updates (see MLZ news 20) in the streamlining of our sample environment for solid/ liquid interface reflectivity measurements at the MARIA neutron reflectometer, we are able to acquire multiple solvent contrast data for up to five different samples in an automated way, that requires minimal user intervention. This simplifies overall data acquisition and permits the user to focus on sample preparation and experimental strategy design during an experiment. However, the increased number of curves acquired during a beam-time creates also the need for a faster check of sample quality and also for a fitting software that may aid the treatment of large datasets.

In a recent publication (J. Appl. Cryst. (2019). 52, 538-547), we presented an integrated software approach that combines an Indirect Fourier Transform (IFT) of the reflectivity data for estimating the extension of the studied interfacial layer, and a subsequent minimisation procedure of multi-contrast reflectivity data, permitting the recovery of the scattering length density (sld) and solvent volume profiles at the interface without the need for any prior assumptions concerning the interfacial structure.

An example of such application using data acquired at MARIA is shown in the figures. Experimental reflectivity data (three solvent contrasts) from a supported

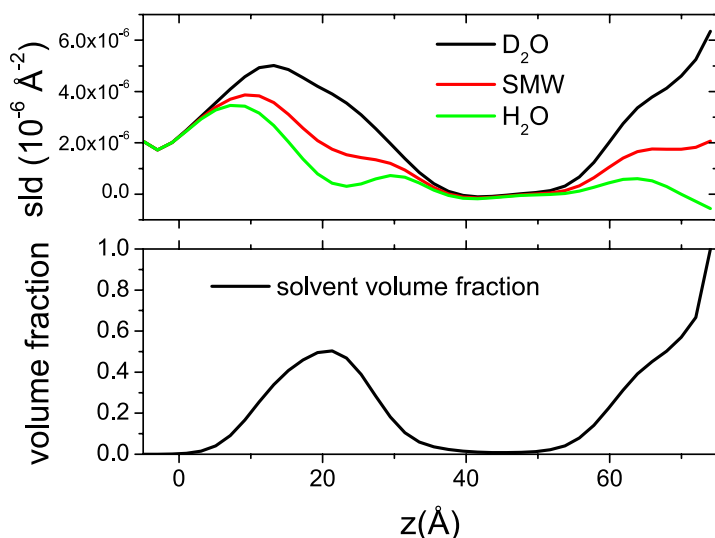


Fig. 2: Composite SLD (top) and solvent volume fraction (bottom) profiles of the biomimetic membrane. Note the characteristic dip of sld and solvent volume fraction at around the middle of the profiles, due to the presence of water-impenetrable hydrocarbon tails.

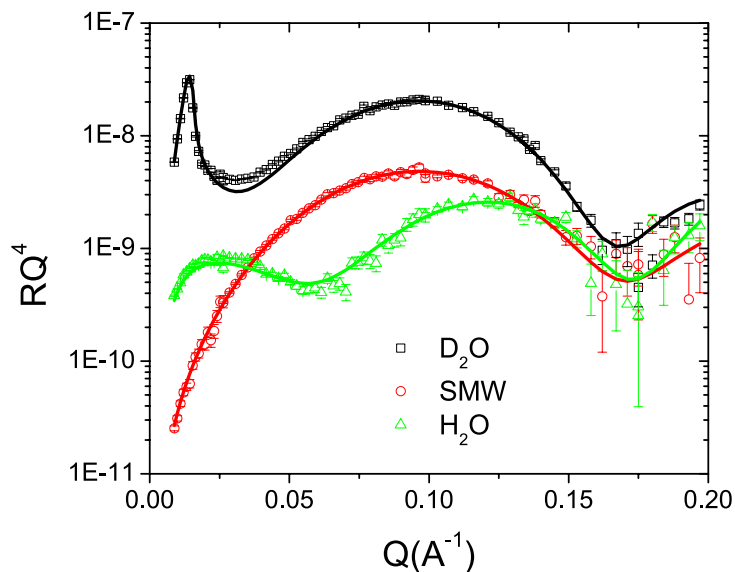


Fig. 1: Experimental reflectivity data for a biomimetic membrane at the silicon/water interface and at three different solvent contrasts (points) and the corresponding fitted reflectivity curves (solid lines).

lipid membrane on silicon (fig. 1), are treated using the mentioned methodology. The recovered sld, and solvent volume profiles (fig. 2) are informative about the molecular distribution at the interface and are typical of a membrane system. Real space resolution in the final models is only limited by the highest accessible momentum transfer ( $Q$ ) in the data.

This automated procedure offers the possibility to check sample quality during the evolution of an experiment and also get detailed information about the probed interfacial structures that can be used for publication purposes or as an objective starting point for further development of models for fitting the experimental data. The fact that an objective sld profile is obtained based on experimental information alone, may prove valuable in the case of highly complex systems and also aid in avoiding fitting bias due to faulty initial model assumptions.

The software is freely available and is offered by default to our users performing “Soft Matter” research at MARIA (in cases where at least two solvent contrasts for the same system are measured). The first use cases in the 2019 reactor cycle showed great potential for the overall improvement of user experience at the instrument.

A. Koutsioumpas (JCNS)

## In-situ structural information of soft materials under different flow fields at KWS-2

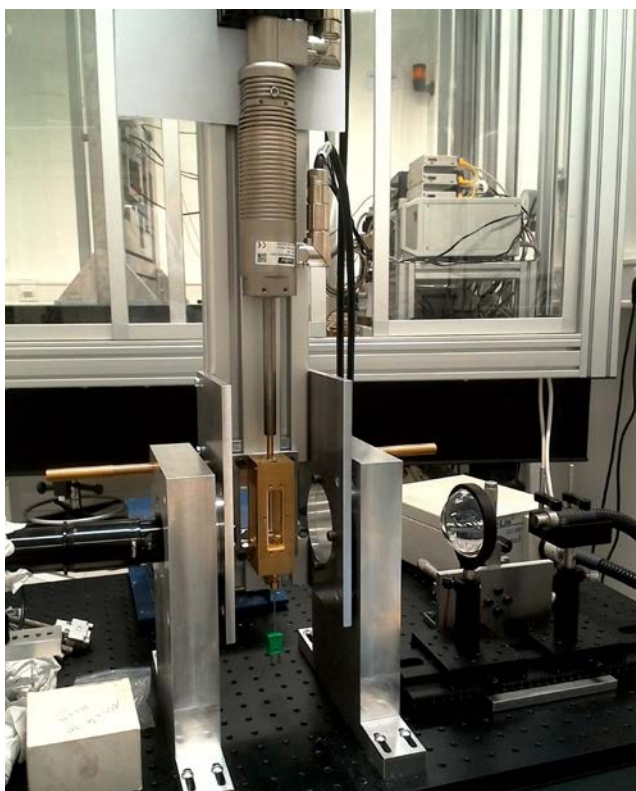


Fig. 1: Home-built CaBER set-up. Photron fastcam to the left, sample chamber in the middle, halogen backlight to the right.

In the form-giving process of many soft materials, the ultimate goal is to create a product with the desired properties by applying the material to mostly very complex flow fields and subsequently quenching the liquid state. An example is the extrusion process, where a polymer melt is shaped by a sequence of complex flow situations and ultimately cooled down until frozen. During such a process, the material substructure undergoes significant changes due to a competition between the Brownian motion of the molecules, their interaction, and the flow field. Understanding the ef-

fect of different flow fields on the substructure of soft matter is thus key to being able to shape a material and obtain the desired properties.

At KWS-2, we have established a coupling of small angle neutron scattering with conventional rheology (rheo-SANS), using the latest Anton Paar MCR 702, and currently plan the installation of a capillary breakup extensional rheometer (CaBER) prototype, see fig. 1.

These two set-ups will soon allow us to apply many industrially relevant flow fields to the liquids under investigation and simultaneously determine the molecular substructure. With the MCR 702, we currently can apply oscillatory as well as steady deformations with the additional option of orthogonal superposition of flows. With the CaBER set-up, we could determine the uniaxial extensional viscosity  $\eta_e$  of samples while obtaining in-situ structural information.

An exemplary investigation of different concentrations of two rod-like polymer suspensions with different flexibility in terms of persistence lengths (fd with  $L_p = 2 \mu\text{m}$  and fdY21M with  $L_p = 10 \mu\text{m}$ , but identical contour lengths) revealed that the so-called hairpin formation of semi-flexible polymers under steady shear flow, as measured with conventional rheo-SANS, could not be occurring during elongational deformation, using CaBER, see fig. 2. This severe effect of the applied flow field on the material substructure is rheologically characterised by the viscosity  $\eta$  of the flexible polymer being higher than that of the stiff polymer at high shear rates  $\dot{\gamma}$ , fig. 2 (a), while the situation is reversed under elongational flow, see fig. 2(b). We

conclude that an optimal degree of molecular alignment, ultimately enhancing the suspension properties in the flow direction, can be either achieved by using particles with a high enough stiffness or by applying extensional flow instead of shear flow, as indicated by the 2D scattering patterns in fig. 2 (axisymmetric in the isotropic and asymmetric in the anisotropic state). This conclusion could finally be confirmed using CaBER-SANS.

C. Lang (JCNS)

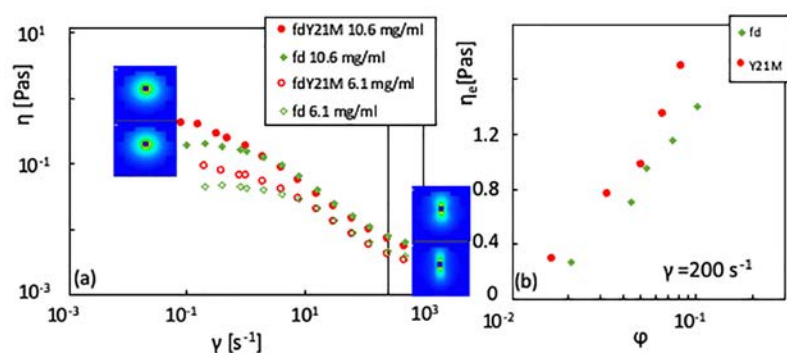


Fig. 2: (a) Shear viscosity as a function of shear rate for stiff fdY21M and flexible fd virus at two concentrations. (b) Extensional viscosity as a function of concentration for an extension rate of  $200 \text{ s}^{-1}$ . Insets: 2D scattering patterns.

## Neutron Activation Analysis is available for users

H																			He	DL
Li	Be											B	C	N	O	F		Ne	1.E-12	
Na	Mg											Al	Si	P	S	Cl	Ar	1.E-10		
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	1.E-08		
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	1.E-05		
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi					0.001	
																				0.1
		La	Ce	Pr	Nd		Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf			ND
			Th		U															g

Fig. 1: Detection limits for the chemical elements using NAA at FRM II.

Within the FRM II reactor, several highly thermalised, high-flux irradiation channels are available for Neutron Activation Analysis (NAA). During neutron activation, a sample is irradiated with neutrons, the atomic nuclei capture them, i.e. they are activated, and radioactive isotopes of certain elements are formed. The delayed gamma rays following the radioactive decay can be used for qualitative and quantitative analysis.

Not all chemical elements produce measurable radionuclides: from the light elements in the first three periods of the periodic table, Na is the only one that strongly activates. (For the determination of the typical matrix components, prompt gamma activation analysis is much more suitable.) NAA's strength lies in the determination of heavy elements in and above the fourth period. The detection limits for many of them is on the level of picograms, or even less like for Mn, Sc, Au, several rare-earths – and this makes NAA an indispensable trace-element analytical technique even today. (fig. 1)

The measurement is as follows: four samples with masses of 10-100 mg are placed in a polyethylene capsule. They are irradiated in one of the irradiation channels with a neutron flux of  $10^{13}$ - $10^{14}$  cm<sup>-2</sup> s<sup>-1</sup>. After activity check, the irradiation capsule is sent to the counting lab in the Department of Radiochemistry.

Here, the samples are separated, and are counted using HPGe detectors equipped with digital spectrometers (fig. 2). The different radionuclides have different half-lives which can be used to increase the dynamic range of the technique. A complete analysis needs a short (typically a few minutes long) irradiation, and a long one (several hours, max. one day), and in both cases more gamma-ray countings. In the repeated measurements, shorter-lived nuclides decay away and enable the precise determination of longer-lived ones. From the peak areas in the gamma spectra, activities and the masses of the activated elements can be determined. Two-to-four samples can be analysed per day.



Fig. 2: A high-purity germanium detector with shielded counting chamber.

Typical trace-element analytical application of NAA is the determination of finger-print elements in archaeological finds, where the composition allows for a provenance study. The pollutants in environmental or biological samples, and air filters, impurities in high-purity materials (e.g. plastics or silicon) are of interest for industry partners. Geological samples and meteorites can also be characterised and classified with the method.

Scientific proposals can now be submitted to PGAA for measurements with NAA. Analyses can also be ordered similarly to other industrial applications.

Z. Revay (FRM II)

## SINE2020 supported School on Neutrons for Membrane Biophysics

In mid-September 2019, we had the pleasure of organising the SINE2020 supported 5-day school with the title “Neutrons for Membrane Biophysics” at MLZ. The event that was attended by about 20 graduate students from Europe, Russia and Australia, primarily focussed on the use of neutrons and molecular deuteration for enabling early career researchers to gain fresh insight into problems related to the physico-chemical properties of biological membranes.

The workshop’s aims were: to give a practical background in the design of neutron diffraction, small-angle scattering, inelastic scattering and reflectivity experiments (including utilisation of molecular deuteration); preparation of samples; successful execution of a measurement programme with hands-on experiments at two MLZ instruments (MARIA & MIRA); and the anal-

ysis of data. Software packages suitable for the analysis of data were introduced, while also exciting possibilities of directly comparing molecular dynamics simulations with neutron scattering data were explored. The kind participation of lecturers from MLZ and other institutes in Europe, contributed to the success of the event.



*A. Koutsioumpas (JCNS)*

## 23<sup>rd</sup> JCNS Laboratory Course Neutron Scattering

The 23<sup>rd</sup> Laboratory Course Neutron Scattering of the Jülich Centre for Neutron Science (JCNS) took place September 2<sup>nd</sup>-13<sup>th</sup>, at Forschungszentrum Jülich (FZJ) for the lecture part and Heinz Maier-Leibnitz Zentrum (MLZ) Garching for the experiments.

The labcourse is open to students of natural sciences from all over the world. Participation is free of charge and travel expenses are subsidised. The course is financed by FZJ with support from the EU projects SINE2020, SoftComp, and EUSMI. As in the years before, the number of participants was limited to 55, selected from more than twice that many applications. About half of the students came from foreign institutions of 14 countries. The participation of female students was 36%.

The first week of the course was dedicated to lectures and exercises on theory, instrumentation, and applications in condensed-matter research. In the second week, twelve world-class instruments were made available at MLZ Garching. Due to the unplanned break, experiments could only be performed as ‘dry runs’. Nevertheless, the students enjoyed doing this

in the actual laboratory environment. They also appreciated that components of the instruments could be visited which are inaccessible during operation.



The next JCNS laboratory course will take place August 31<sup>st</sup>-September 11<sup>th</sup>, 2020. You are cordially invited to submit applications at [www.neutronlab.de](http://www.neutronlab.de) (opening January 2020).

*R. Zorn (JCNS Jülich)*

## German-French workshop

Scientists of the MLZ and the 2DFN (La Fédération Française de la Diffusion Neutronique) discussed the opportunities of an enhanced cooperation among German and French neutron scientists during a workshop at the research campus in Garching. Europe is leading in neutron science due to the Institute Laue-Langevin, the future European Spallation Source, and a network of powerful national sources like the FRM II. However, the closure of the two national sources Orphée



© B. Pedersen (FRM II)

in France and BER II in Germany together with the increasing competition from Asia will lead to a change in the European neutron landscape. This will increase the future demand at the MLZ drastically.

And the situation demands for a stronger German-French cooperation. The MLZ hopes for assistance to provide more sophisticated and innovative instrumentation and is looking forward to exploring new fields of neutron science. The 2DFN hopes for support regarding the education of France's prospective neutron scientists. Virginie Simonet, the director of the 2DFN explains: "With the closure of Orphée we lose our education programme and risk losing knowledge in neutron science." The MLZ for its part supports over 200 PhD students per year, offers practical courses and lectures at the TUM and at its partner universities, and promotes the establishment of an international doctoral programme.

*L. Heyer (FRM II)*

## 1<sup>st</sup> Experts Meeting on Fast Neutron Imaging



On October 20<sup>th</sup>-23<sup>rd</sup>, 2019, the Neutron Imaging Group at MLZ was hosting the 1<sup>st</sup> Experts Meeting On Fast Neutron Imaging. The meeting featured presentations and discussions on the latest advancements and applications of fast neutron imaging with 32 international participants from industry and research facilities.

Fast neutrons are an invaluable probe and provide information for non-destructive inspection of large and dense objects where thermal neutrons or X-rays face limitations due to their comparatively low penetration. Only few facilities around the world provide access to fast neutrons with NECTAR at the MLZ being the only beamline that has a dedicated user programme for fast neutron imaging.

The meeting brought together the experts in the field from around the world and provided a pathway for quantification and standardisation of imaging set-ups at different facilities, as well as for improving resolution and efficiency of the technique in a collaborative effort. With an overwhelmingly positive outcome of the 1<sup>st</sup> Experts Meeting On Fast Neutron Imaging, the continuation of this event was confirmed with updates being posted at the International Society for Neutron Radiography ([www.isnr.de](http://www.isnr.de)) website.

*A. Losko (FRM II)*

## MLZ Conference 2019



Pioneered by the Nobel Prize winning works from Bertram N. Brockhouse and Clifford G. Shull, neutron scattering has become an indispensable technique for the microscopic probe of magnetic order and excitations in magnetic materials, strongly correlated electron systems and unconventional superconductors. This has in turn helped to drive the developments in information technology in the past decades. Unsurprisingly, magnetism research with neutrons also represents one of the most active research fields at MLZ.

But the field is developing fast and new fields come up. Therefore the Quantum Phenomena Group of MLZ organised a conference, which covered a wide range of emerging topics in magnetism, that are expected to bear high relevance to the advances of future information and quantum technologies, but are not being explored much by neutron techniques so far.

From June 4<sup>th</sup> to June 7<sup>th</sup>, 2019, this conference about “Neutrons for information and quantum technologies” took place in Lenggries. 45 international participants



met in this nice valley in upper Bavaria, right below the Brauneck. The programme was very broad, ranging from spin caloritronics, molecular magnetism, new trends in spintronics, 2D magnetic van der Waals materials, spin wave and magnonics, dynamics of magnetic textures like domain walls, vortices and skyrmions, quantum theories of spin-structures to spin-textures. Altogether 23 talks were given in nine sessions by worldwide renowned speakers.

The conference excursion consisted in a common hiking to the Stie-Alm a summer dairy in the mountains. Thus, the participants experienced the best of Bavaria: wild nature, mountains – even with snow! – and a typical “Brotzeit”.

*R. Georgii (FRM II) and Y. Su (JCNS)  
on behalf of the MLZ Quantum Phenomena Group*

**Getting interested?  
Don't miss the MLZ Conference 2020!**

**MLZ Conference**  
Neutrons for Life Sciences

June 16<sup>th</sup> - 19<sup>th</sup>, 2020, Arabella Brauneck Hotel, Lenggries, Germany

**TOPICS**

- Protein structure, function and dynamics
- Membrane structure, function and dynamics
- Drug design and delivery
- Biological surface and interface
- Neutron methods in biology
- Life Science at the PIK reactor
- DNA/RNA structure and dynamics, living cells

MLZ is a cooperation between:

**JÜLICH** Forschungszentrum

**Helmholtz-Zentrum Geesthacht**  
Zentrum für Material- und Küstenforschung

**Technical University of Munich TUM**

## Engaging for neutron science: With Brazil nuts and helium balloons

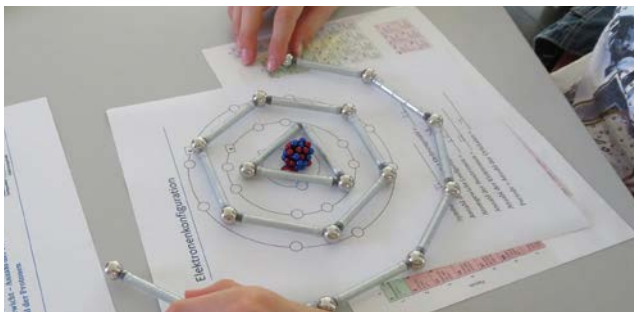
The Press Office of the FRM II and MLZ organised several events and was present at festivals in summer and autumn.

### Girls go Tech



The tour also led the girls into the reactor drivers' control room.

During the summer holidays, the MLZ once again took part in the "Girls go Tech" programme of the Technical University of Munich. Twelve girls had fun building lego robots and got an impression of the work at a neutron source by building an atomic model of their favourite chemical element and detecting the radioactivity of everyday objects. Highlights for the 11 to 13 year old girls were the guided tour with instrument scientist Johanna Jochum and measuring pH and microscopically crystals in the biology and chemistry laboratory with Tabea Bartelt.



Building chemical elements with magnetic sticks.

In September, there were two events, in which the MLZ and FRM II took part with a stand: one local industrial exhibition in Garching and a German-wide physics festival in Bonn.

### Garchinger Herbsttage



Children could build chemical elements using magnetic building blocks.

Several hundred people, among them the mayor of Garching, visited the biannual trade show "Garchinger Herbsttage" on the weekend September 14<sup>th</sup> and 15<sup>th</sup>. It is already good practice since more than twelve years that the FRM II takes part, this time with magnetic sticks to build chemical elements for children and a radioactivity station with banana chips, Brazil nuts and uranium glass to show radioactivity in everyday life.



Dietmar Gruchmann (l.), Mayor of the City of Garching, was interested in measuring radioactivity in everyday products.



## Highlights of Physics

With a similar set-up, the MLZ was also present at the annual German physics festival “Highlights of Physics” in Bonn. It is organised by the German Physical Society DPG and financed by the Federal German Ministry of Education and Research BMBF. The festival with stands, shows, talks and workshops for schools takes place in a different German city each year. After 2012, the MLZ and FRM II have been participating for the second time with a stand in the exhibition from September 16<sup>th</sup> to 21<sup>st</sup>. The festival right on the central place in front of Bonn’s cathedral attracted around 60,000 visitors. The FRM II and MLZ booth scored with helium balloons, a new moving lego model of a three-axes spectrometer, measuring radioactivity in everyday products, stories of research highlights and a crossword on neutron research.



As the exhibition was open until after sunset, the glowing of the uranium glass (above) and the blinking lego model (below) came into effect.



## Open doors and Mouse Day



© A. Heddergott (TUM)

The experiments with liquid nitrogen and the final FRM II-made ice cream were one of the highlights for the children’s tours.

This year, the FRM II was the only institution to open its doors on the entire Garching campus. What could be more obvious than to combine this special day with the Germany-wide open day of the show with the mouse, which traditionally takes place on October 3<sup>rd</sup>? Already, children and parents had enthusiastically received the 2018 Mouse Day at FRM II. So in addition to the programme for 122 children at the ages 7 to 13, there were tours for 399 adults as on a regular open day. With announcements in radio and newspapers, there were more people than the tours could accommodate. But the staff of the Heinz Maier-Leibnitz Zentrum and the Research Neutron Source had put a lot together for an accompanying programme: In lectures, the audience learned about the conversion of the fuel element, the medical applications at the FRM II and research from hydrogen to antimatter. Current films were shown in a second auditorium. Those who preferred to personally talk with researchers were attracted by three information stands and various hands-on activities: Radiation protection presented measurements of radioactivity in everyday life and used a computer game to find the most skilled reactor driver. Dexterity in hitting atoms could be demonstrated at the neutron ball toss game and, with two rotating chopper disks, one could experience how difficult it is to filter out neutrons at a certain speed. The MLZ booth also offered the newly built Lego model of a three axes spectrometer and a real neutron guide. At a third stand, scientists from the TU Munich explained what positrons, the antiparticles of electrons, were.

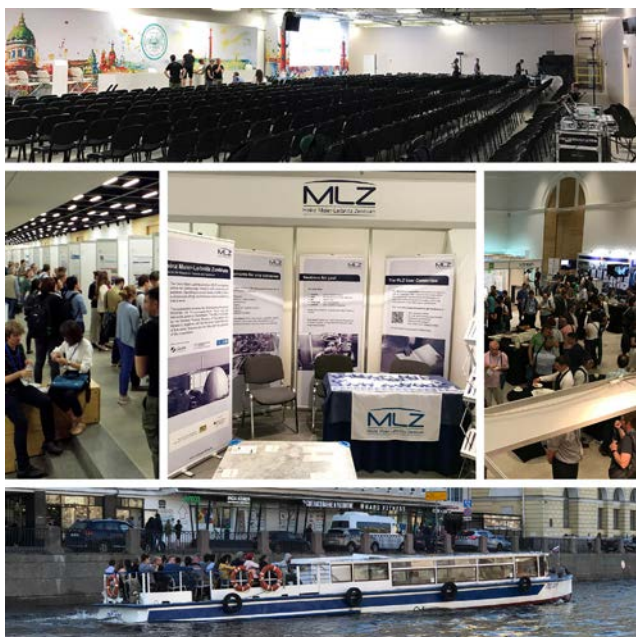
A. Voit (FRM II)

## MLZ is everywhere!

The MLZ is happy to meet its users and users-to-be all over the world. Thus, we like to travel and offer information, ideas, and answers to all your questions at our booths at several conferences. From this summer on, not only the User Office and the Press Office Team is on tour – the MLZ Science Groups also decide about two conferences or workshops each per year where neutrons shall be promoted more. They will attend in the scientific programme as well as being at hand at a booth. In order to facilitate this, the User Office created conference boxes – with all the things one needs to make such smaller booths interesting!

### ECNS 2019

The MLZ User Office itself joined the European Conference on Neutron Scattering 2019 at beautiful St. Petersburg in July. Every four years, the European community gathers and this time, Russia was the host. A total of 572 participants listened to more than 250 talks and had to study 350 posters carefully and three satellite symposia could also be visited: “Scientific Methods for Cultural Heritage“, “Nuclear Medicine“, and “Synchrotron and neutron research and infrastructure” – a broad base for discussions was thus given. Those discussions were not even stopped by leaving the conference venue in order to go for lunch in the biggest steak house of Russia just across the street and therefore, one could meet gesticulating sci-



Impressions from the ECNS 2019.

entists also inbetween. They gesticulated even after the Conference Dinner – but there it was the music making everybody dance!

At the MLZ booth, the User Office staff met many of the 175 Russian, 105 German, and 68 French participants – just counting the biggest groups. It was great to see users again! We can't wait to meet all of them here at Garching next year.

### ECM 32

In August, the MLZ Science Group Structure Research attended the 32<sup>nd</sup> Crystallographic Meeting at Vienna. Moreover, M. Meven (RWTH Aachen/ JCNS) together with J. Schefer (PSI) organised a satellite workshop on “Neutron Scattering and Imaging for Newcomers” and thus the MLZ booth in the beautiful arcaded courtyard – shared with the colleagues of HZB – became the place for further information.



The booth of HZB and MLZ at ECM 32.

### ECIS 2019

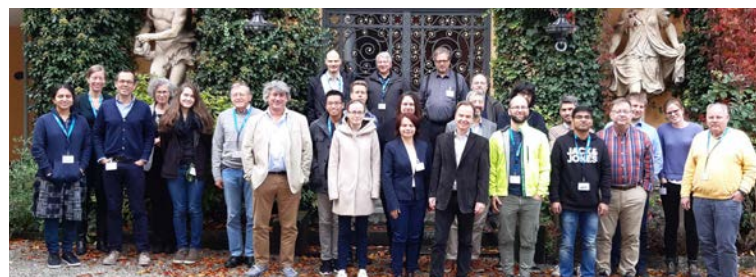
The 33<sup>rd</sup> Conference of The European Colloid and Interface Society at Leuven in September had been chosen by the MLZ Science Group Soft Matter. This interdisciplinary conference was a really good opportunity to get in contact with various groups of scientists working in the field of colloid and interface science and to explain how neutrons can help to answer their questions.

*J. Lommatzsch (FRM II)*

## JCNS Workshop 2019

In 2019, the annual JCNS-Workshop Trends and Perspectives in Neutron Scattering was devoted to the field “Probing Structure and Dynamics in Soft Matter” and held at the beautiful Evangelische Akademie Tutzing at Lake Starnberg south of Munich on Oct. 7<sup>th</sup>-10<sup>th</sup>. An international group of scientists presented and discussed lively 41 invited and contributed talks.

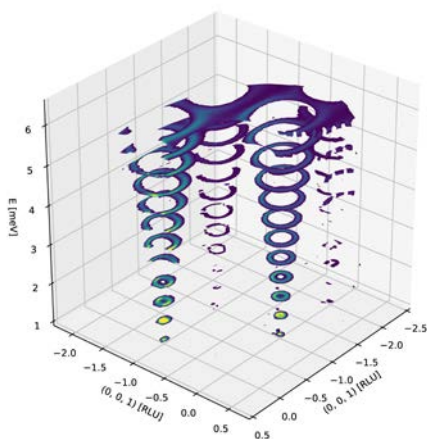
Neutrons are a key probe providing deep insight into the structure and dynamics and thus in the functioning of synthetic and living soft matter. Understanding of the atomic and molecular function of polymers and nanocomposites are tackled by neutron methods, but also the dynamic behaviour of soft matter out of equilibrium or in confinement is investigated. Here soft matter also meets biology regarding the structure and function of membrane components, proteins or complex aggregates.



The workshop brought successfully together experts in neutron scattering methods with users from soft matter and biology to review techniques and provided the opportunity for the community to discuss current limitations, new capabilities, and future developments. The topics were quite broad covering adaptive and responsive polymers, shape memory systems, smart polymers, nanomaterials, complex fluids and self assembly studied by time resolved studies, pump-probe experiments together with simulation and specialised data analysis.

*S. Mattauch (JCNS)*

## Workshop on TAS



MJOLNIR visualisation of  $\text{MnF}_2$  spin wave measured on CAMEA.

Today, this cooperation does not only generate efficiency and sustainability, but can provide an improved service for the users who mainly visit all of the available neutron sources, too. Following this mind, the teams of upcoming “Multi-TAS” instruments CAMEA (PSI), BAMBUS (MLZ) and BIFROST (ESS) decided to suggest a general data access giving the users a similar

feeling for the measurements and data processing across the facilities. Within the community, there exists a long-time cooperation between the instruments scientists of the European facilities.

Today,

feeling for the measurements and data processing across the facilities. MARMOT (ILL) intends to join this project. Saving time by avoiding double-work we intend to provide the full set of data analysis service including resolution calculations (e.g. by extension of TAKIN to the out-of-plane scattering).

On October 16<sup>th</sup>, the MULTI-TAS teams met at MLZ to coordinate software developments. The status of the instruments was reported. CAMEA presented first results, including the data visualisation by a package MJOLNIR. BAMBUS is under construction. The GUI and the detector-to-nicos connection is under development. Now, the implementation of TAKIN and the tasks for BIFROST are under discussion.

PUMA and KOMPASS teams discussed their constraints for a possible later extended version. Members of the MLZ QP science group participated for a science talk of Henrik Jacobsen

*A. Schneidewind (JCNS)*

## The SINE2020 Story



Four years have gone by and Science and Innovation with Neutrons in Europe in 2020 (SINE2020) has ended. SINE2020 partners in 18 institutions (fig. 1) have worked tirelessly since October 2015 to initiate and develop successful research and innovation projects to add to Europe's neutron infrastructure.



Fig. 1: The SINE2020 partners: ILL (FR), LLB/CEA/CNRS (FR), MLZ/TUM (DE), FZJ (DE), HZB (DE), HZG (DE), ESS (SE), ESS-Bilbao (ES), ICMA (ES), LIP (PO), PSI (CH), University of Parma (IT), MTA EK (HU), NPI (CZ), STFC (UK), DTU (DK), University of Copenhagen (DK) and TU Delft (NE)

SINE2020 has three over-arching goals. To develop innovation at neutron and muon sources, to improve efficiency at existing facilities and to prepare for the European Spallation Source in Sweden so that it can be used to its full potential from day one.

Why are these goals important? To support excellent science with neutrons and to make an impact on society. Developments save beam time losses, allowing more users to gain access, and extend the use of neutrons into new scientific fields – from materials to medical applications. We want to make the most of opportunities that neutrons and the ESS can bring to science and innovation. SINE2020 has been an important step along this road.

### People, people, people

The neutron community already has a well-established degree of coordination and cooperation. However, SINE2020's Networking activities aimed to share know-how and infrastructure to reinforce long-term sustainability.

#### Engaging with Industry

SINE2020's Industrial Liaison Officers promoted the unique benefits of neutron techniques to industrial companies, attending and hosting many events to engage with them. 37 companies, ranging from the automotive to the biotech sectors, took up SINE2020's free feasibility studies offer to test out neutron techniques. Example Case Studies are on the website [sine2020.eu](http://sine2020.eu).

#### Training new users

SINE2020 supported the training of participants in 42 Introductory and Advanced-level Neutron Schools by funding those that would not otherwise have been able to attend. However, with neutron facilities inaccessible for many, SINE2020 also established the interactive e-learning platform [e-neutrons.org](http://e-neutrons.org), now providing users with neutron-related online courses and learning materials that can be accessed anywhere, anytime.

#### Providing deuterated materials

SINE2020 created DEUNET – a sustainable network of deuteration laboratories with complementary expertise and joint capabilities to produce a wide range of compounds. This addresses the urgent need for user access to deuterated molecules, rarely available commercially. SINE2020 also realised new synthesis routes for deuterated polymers, surfactants and bio-molecules.



Fig. 2: SINE2020 General Assembly participants in Parma, 2018.

## Research and Collaboration

SINE2020's Joint Research Activities addressed sample, instrumentation and software projects:

### Growing crystals

SINE2020 developed equipment and methods to increase the size of protein crystals and explore magnetic-alignment of microcrystals for neutron crystallography techniques that require large crystals. This is not easy, but could allow neutron techniques to be exploited by structural biology and pharmaceutical fields.

### Sample Environment

SINE2020 sample environment developments can apply 1.5 times more pressure on samples, and make the experimental set-up process more efficient, e.g. by speeding up cooling processes in cryostats or furnaces and tuning the orientation of single-crystals at ultra-low temperatures. The definition of the Sample Environment Communication Protocol facilitates sharing and installation of equipment. Users also have access to new in-situ NMR techniques on neutron beamlines and in-situ muonium chemistry on  $\mu$ SR instruments.

### Instrumentation

SINE2020 developed ingenious detectors to improve count rate, decrease signal-to-background noise and reduce reliance on Helium-3. In preparation for the ESS, SINE2020 developed novel neutron shielding and recommended compact polarised Larmor instrumentation. SINE2020 also progressed the capacity and accuracy of simulation software, useful for experiment preparation and analysis.

### Data Treatment

SINE2020 has made existing data treatment software more user-friendly and functional to suit a broad-

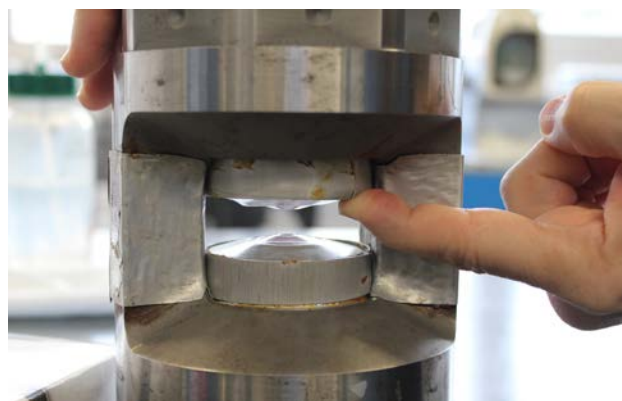


Fig. 4: Next-generation anvils for the Paris-Edinburgh cell.

er profile of neutron users. Software Standards and Guidelines, now established, will ensure ongoing accessibility for the community.

## The future

The end of SINE2020 coincides with structural changes at the European Commission, where the Horizon 2020 framework comes to an end. ([ec.europa.eu/info/horizon-europe-next-research-and-innovation-framework-programme\\_en](https://ec.europa.eu/info/horizon-europe-next-research-and-innovation-framework-programme_en)). The European neutron community has already prepared itself for new Horizons with the formation of LENS – the League of advanced European Neutron Sources ([www.lens-initiative.org](http://www.lens-initiative.org)).

The new LENS working groups incorporate existing SINE2020 networks with ongoing projects. The current definition of the next framework programme creates uncertainty and forces the neutron community to define priorities. With LENS, facilities should demonstrate that, working together, combating new scientific and technical challenges is possible, even if they are beyond the scope of individual partners.



Fig. 3: The DEUNET Network

For more details on all the SINE2020 activities and projects, and to read the SINE2020 Sustainability Report, please visit our website [www.sine2020.eu](http://www.sine2020.eu). This project received funding from the European Commission Horizon 2020 research and innovation programme under grant agreement No. 654000.

*L. Moorcraft (SINE2020)*

# Next Proposal Deadlines



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**Keep an eye at**

○ [mlz-garching.de/user-office](https://mlz-garching.de/user-office)



## Dear colleagues,

In times when neutrons became a rare value in Europe we are looking forward now to experiments, partially planned at MLZ a year ago. Many users understand the complexity of operating neutron sources successfully. Nevertheless, in consequence of the delay, we all need to work hard to ensure that the students affected can finish their theses in time. In addition, externally funded projects run into time limits to fulfill their promises, which could influence further funding opportunities, too.

To keep young scientists engaged in neutron scattering, and to keep the user's third-party funding sustainable, we need to find a way to increase the amount of available beamtime as well as the reliability of the schedule.

This available beamtime needs to be exploited in the most efficient way. To find the best-suited instrument for a scientific question, to develop the right strategy during the experiment, to search for deeper and faster data analysis – these are the steps users and instrument scientists are experienced to succeed. For the future, it will be necessary to open our minds for more and new measures. E-learning could speed up the training of new users, show the opportunities and chances of neutron scattering. Virtual instruments allow to simulate the experiment beforehand and at home, offering the possibility to try and play without neutrons – and we can arrive for the beamtime with a safe efficient experimental plan. Improved data visualisation give chance for a faster interaction during the experiment. These are the known ideas we can apply – please join for thinking beyond!

Hope to meet you for experiments in 2020 at MLZ!  
Have a peaceful Christmas time before.  
Astrid Schneidewind



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Astrid Schneidewind

Chair of the 11<sup>th</sup> KFN  
(Komitee Forschung mit Neutronen)

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## What are users doing?



The MLZ User Committee meeting in Garching in January 2019.

### User Committee members

#### Adrian Rennie (Chair)

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#### Jens Gibmeier

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#### Rainer Niewa (KFN Observer)

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*The enthusiasm for science with instruments around FRM II is high because they can provide very direct answers to important questions. This year there has only been a short opportunity for experiments at MLZ with half a cycle of reactor operations. Users are however still very active. They participate in many conferences and workshops. Particularly when these are oriented to scientific problems rather than experimental methodology, this use of time away from our home laboratories allows us to act as ambassadors for the facilities that we use.*

*At present we do not meet frequently in Garching. Informal discussions that come with work at a large research facility have numerous advantages. Apart from contact with friends, we learn about recent scientific developments and what is happening elsewhere. For the User Committee, reduced contact has a consequence that we have less feedback. Our experience is that many people share views during informal meetings but may not contact us directly by e-mail or telephone.*

*While there may be fewer comments about instruments, analysis of data is certainly on-going. It would be timely to give feedback on software. There is continuing development and it is helpful to provide ideas or report problems so that this work is effective.*

*Your suggestions, ideas and thoughts on any topic concerning MLZ are always welcome and can be communicated to any member of the User Committee. I write this looking forward to discussions at the User meeting in December.*



## Newly arrived at the MLZ!

I'm **Christopher Howard** and I am a PostDoc and instrument scientist on SAPHiR, helping to further develop the instrument and to perform my own high-pressure experiments on a range of materials. I obtained my PhD at University College London, where I performed several neutron diffraction experiments under extreme conditions on ices found in the outer solar system. My research interests are in working with materials under extreme conditions, using a combination of DFT and crystallographic techniques, such as high-pressure diffraction experiments.



[christopher.howard@frm2.tum.de](mailto:christopher.howard@frm2.tum.de)

I'm **Apostolos Vagias** and I joined SANS-1 as instrument scientist /PostDoc. I desire to contribute at MLZ to user support in soft matter and pursue collaboration within MLZ, TUM and worldwide. My former scientific projects (Uni Groningen, FZ Jülich, MPIP Mainz, University of Minnesota), involved: nanostructural changes during drying in paint coatings by in-situ GISAXS, microrheology in polymer melts under pressure, tracer transport in hydrogels via Fluorescence Correlation Spectroscopy and surfactant self-assembly in water.



My interests? Nanostructure-dynamics in soft matter, buried structures and dynamics in polymer films!

[apostolos.vagias@frm2.tum.de](mailto:apostolos.vagias@frm2.tum.de)

I'm **Frank Kümmel** and I am scientist in the Advanced Materials Group and my research is focussed on the correlation between microstructure and mechanical properties of metallic materials. During my PhD at the FAU Erlangen, I examined the deformation and failure mechanisms in ultrafine-grained lamellar metallic composites. At the MLZ, I will investigate  $\gamma/\gamma'$ -hardened polycrystalline Ni-based high-temperature alloys. To get a deep knowledge of the precipitation kinetics, a new testing machine is built up that enables mechanical loading at temperatures up to 1200°C in-situ at various instruments at the neutron source.



[Frank.Kuemmel@frm2.tum.de](mailto:Frank.Kuemmel@frm2.tum.de)

## A 2000 year-old computer goes interactive



© W. Schürmann (TUM)

Markos Skoulatos, instrument scientist at the FRM II, recreated a functional Antikythera mechanism, as one of a few people worldwide

The 2000-year-old antique computer has not let go of Markos Skoulatos ever since he watched a documentary on BBC in 2012. This rusty instrument that sponge-divers discovered in the sea in 1900 off the Greek island Antikythera is a one of a kind. However, until X-ray tomography data were collected in 2005, no one could decipher the mechanism.

The Antikythera mechanism is an astronomical calculator. It sunk together with a ship around 60 BC in Greece, between Peloponnese and Crete. It is operated with a side handle that sets a date, and in the same time calculates a wealth of information about the sun and moon phase, planetary motion, solar or lunar eclipses and even Olympic Games. That makes it the first “computer” of humanity. Researchers suspect that the original was used in ancient times to teach astronomy.



© M. Skoulatos, G. Brandl (MLZ)

A view of the app, programmed by Georg Brandl and Markos Skoulatos, which will be released by the end of November.

“This astronomical calculating machine raised my researcher’s ambition” says Markos Skoulatos, the 36-year-old instrument scientist from the Technical University of Munich. “I wanted to understand the Antikythera mechanism and make an exact replica.” For two years, Markos Skoulatos immersed himself in all the data and documents he could find about the fabled astronomical clock. At the time, he worked as a post-doc at the Paul Scherrer Institute in Switzerland, married and had two children. “I often sat over the papers at night when the family slept,” says Markos Skoulatos. After lots of calculations and modeling, he went to production and finally successfully assembled the “machine” in his basement.

In 2014, he presented a functional Antikythera mechanism, with only a handful of others available worldwide. And the charm of his model: the surrounding plexiglass allows the view of the mechanism inside. “I wanted to show the beauty of the mechanism such that my children and other people learn something when they look at the device” explains Skoulatos.

More information about the functionality of the mechanism and some documentation of his project is shared at his website ([www.eternalgadgetry.com/index.html](http://www.eternalgadgetry.com/index.html)).

Markos Skoulatos is continuing with his replica in this tradition of teaching and learning. He already gave several lectures about the Antikythera mechanism, for example at the Pint of Science in Munich, the Glyptothek in Munich, school classes in Germany, Greece and elsewhere. More recently, Skoulatos together with his MLZ-colleague Georg Brandl has been creating a model that can be controlled via WiFi from a tablet or smartphone. It can be offered to museums, such that visitors can operate the astronomical calculator without touching the valuable parts. Brandl and Skoulatos have also been developing an Antikythera app for smartphones, which will be released by the end of November. “It enables you to orient yourself in the night sky, and make various predictions about the moon, eclipses, and planetary motions.”

A. Voit (FRM II)

## Honour for the “Father of PUMA”

Götz Eckold has now been awarded the Prize for Instrumentation and Scientific Use of the MLZ for his many years of extraordinary commitment. The MLZ honours his great commitment to instrumentation and in particular the instrument PUMA.



Peter Müller-Buschbaum (r.) symbolically presents Götz Eckold an aluminium model of the FRM II.

Götz Eckold already had the blueprint for the new measuring instrument in his pocket before the start of FRM II's construction. At the first planning meeting for the FRM II instruments in 1995, the man from Göttingen already knew exactly what he wanted: a three axes spectrometer that measured with thermal neutrons and opened up new measuring possibilities beyond the then widely used design. A very similar idea came from the group of Winfried Petry, at that time appointed Scientific Director of the FRM II project. “We then quickly merged our plans,” says Winfried Petry. The result was PUMA, which was realised after a short construction period thanks to funding from the Federal Ministry of Education and Research (BMBF) to the University of Göttingen and has been available to German and international researchers since the start of routine operation of the FRM II.

Scientific Director Peter Müller-Buschbaum symbolically presented Götz Eckold with a miniature model of the research neutron source made of aluminum at a meeting in September. In his laudatory speech, Müller-Buschbaum emphasised: “Götz Eckold's special commitment to continuously developing the instrument and the associated technologies has led to almost 20 years of funding for PUMA from the BMBF until 2018.” Götz Eckold can also be justifiably called

the intellectual “father of PUMA”. But the heart of Götz Eckold was not only beating for PUMA. In his own workshop in Göttingen, Götz Eckold also had the focusing monochromators and copper monochromator crystals developed for PUMA produced for other measuring instruments at the FRM II.

Since its commissioning in 2005, the PUMA instrument has developed excellently. International groups use PUMA to study a wide variety of samples, such as superconductors, that lead to spectacular results published in very renowned scientific journals such as Nature or Science.

Götz Eckold has been professor at the Institute of Physical Chemistry at the Georg-August-Universität Göttingen since 1996. From 1993 to 1999, he was an active, elected member of the Committee for Research with Neutrons in Germany (KFN) and was Vice-Chairman of the KFN from 2005 to 2008 and its Chairman from 2008 to 2011. For the FRM II, Götz Eckold was chairman of the instrumentation advisory committee and member of the scientific advisory board/ steering committee from 2001 to 2006. Since October 1<sup>st</sup>, 2019, he has been officially retired.

*A. Voit (FRM II)*



© B. Ludewig

The three axes spectrometer PUMA with instrument scientist and technician seen from an artistic perspective.

## Newly arrived at the MLZ!



I'm **José Gomez** and joined as instrument scientist at the TREFF reflectometer. I got my PhD in Spain in low energy Accelerator Mass Spectrometry (AMS), where we measure tiny amounts of long-lived radionuclides by using an accelerator. The results from these measurements are used later on in different fields, like astrophysics, material science, environmental problems, etc... In 2011, I came as a PostDoc to the E12 chair in the TUM Physics Department to work both in high energy AMS (at the MLL) and developing STJ (a type of cryogenic detectors) to be used in the future in AMS measurements. Until now, my main scientific interests were high energy AMS and specially the development of the STJ, this latter field including studies to improve cryostat's performance, electronics, data acquisition, etc.. And, obviously, neutron scattering!

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I'm **Yiyong Han** and I am a PostDoc at ANTARES and will participate in the development of the high-resolution and high-sensitivity neutron imaging system. I obtained my PhD at Technical University of Munich working on photoacoustic imaging. Then I did my PostDoc training at Purdue University (Indiana, USA), where I developed various optical imaging systems for neuroimaging. I am interested in the application of imaging and image processing.

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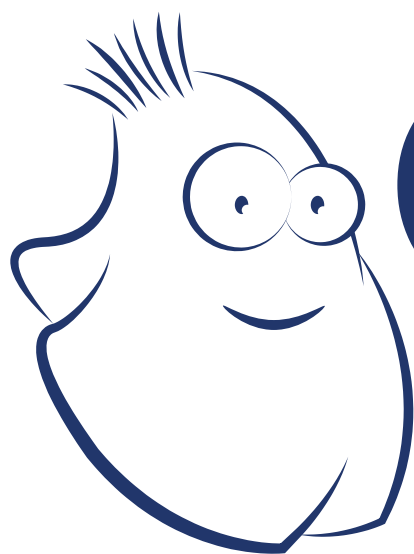


I'm **Mathieu Jacot-Guillarmod** and I am working on the ANTARES beamline, on the design and implementation of a new high-resolution and high sensitivity neutron imaging system. This new technology will be used to investigate the dynamic water transport in alkaline fuel cells and electrolysers. During the few past years, I studied the water transport in the porosity network of iron corrosion products. This research was made using multiple 3D imaging techniques, including X-ray, neutron and focussed ion beam tomography. Meaningful characteristics of the material were then extracted from the images using topological concepts. I am interested in imaging in general, as a complete process including image acquisition, treatment and analysis. Even further, I like to transform the images into abstract models where only the most important information are kept, or to use 3D images as virtual objects for virtual simulations.

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Will newly arrive on December 10<sup>th</sup>: <https://ghost.mlz-garching.de>



# GhOST

## Garching Online System Tool

### Meet GhOST at the MLZ User Meeting!

From December 10<sup>th</sup> on, GhOST will start helping all users (and all involved persons and departments in-house) with the workflow at the MLZ. At the User Meeting, you will have the opportunity to create your account and have a look at the new interface – and ply us with questions!

### I will visit the MLZ for experiments in the upcoming cycle – what do I need to know?

The first cycle in 2020 had already been scheduled in our current system – thus you will also have to use it in order to apply for your visits during the time January to March.

### Why do I need to create my account as soon as possible?

The second cycle will be scheduled in GhOST and from then on the whole experiment workflow will use this new system. In order to do this, we need to transfer all still open proposals to the new system. Due to technical reasons, we can't just copy them....

And here we need you! In case

- you are a main proposer and
- your open days are not scheduled until the end of the first cycle in 2020,

the system will check automatically when you confirm your account and save those proposals in GhOST. Afterwards, they can be scheduled.

In short: Your open proposals can not be scheduled without your confirmed account!

### What about the next proposal deadline?

The next proposal deadlines will run via GhOST. We will publish the date of the next deadline in the beginning of 2020.

## UPCOMING

### DPG Spring Meeting of the Condensed Matter Section

March 15<sup>th</sup>- 20<sup>th</sup>, Dresden (Germany)

<https://dresden20.dpg-tagungen.de>

*Visit our booth there!*

### 51<sup>st</sup> IFF Spring School - Quantum Technology

March 23<sup>rd</sup>- April 03<sup>rd</sup>, Jülich (Germany)

<http://www.iff-springschool.de/>

### MLZ Conference 2020:

Neutrons for Life Sciences

June 16<sup>th</sup>- 19<sup>th</sup>, Lenggries (Germany)

<https://indico.frm2.tum.de/e/NeutronsForLifeSciences>

### 24<sup>th</sup> JCNS Laboratory Course – Neutron Scattering 2020

August 31<sup>st</sup>- September 11<sup>th</sup>, Jülich + Garching (Germany)

[www.neutronlab.de](http://www.neutronlab.de)

## Reactor Cycles 2020

No.	Start	Stop
47	14.01.2020	13.03.2020
48	07.04.2020	05.06.2020
49	11.08.2020	09.10.2020
50a	01.12.2020	18.12.2020



*Wishing a Merry Christmas  
and  
a Happy New Year!*

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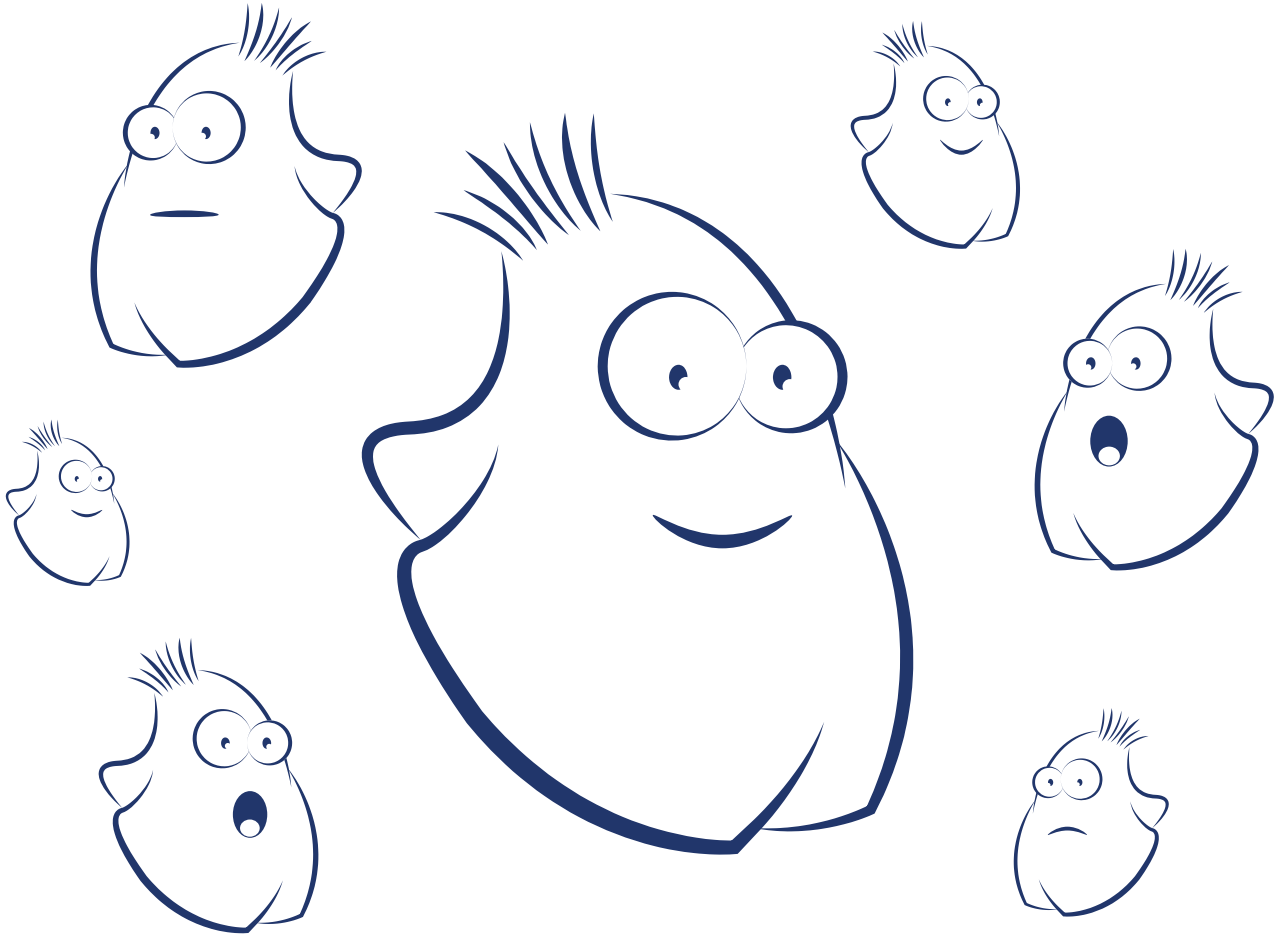
[www.mlz-garching.de](http://www.mlz-garching.de)



## *Finally!!!!*

This year, we hosted a kestrel family with four nestlings on-site. They loved our new buildings (which are still under construction) and we loved to see the nestlings looking first really anxious around but then learning to fly. This one was the little one – and now it conquers the sky as well!

Photo taken by Christian Müller (FRM II)



# GhOST

Garching Online System Tool