# 中德工程材料中子散射论坛暨中子全衍射轮廓拟合辅导班

**Sino-German Forum on Neutron Scattering in Engineering Materials**
**& Tutorial on Neutron Whole Diffraction Profile Fitting**

## 一、概况

本论坛暨辅导班依托国家自然科学基金委（NSFC）与德国研究基金会（DFG）联合资助的中德“流动计划（Mobility Programme）”举办，聚焦德国慕尼黑工业大学 MLZ 研究中心第二研究型反应堆(FRM II)工程材料谱仪 STRESS-SPEC 与中国散裂中子源（CSNS）工程材料谱仪团队双向学术交流，定于 **2026 年 9 月 13-18 日**在**广东东莞**开展。

中子散射作为无损表征核心技术，可解析工程材料内部微观结构、残余应力，广泛应用于航空航天、轨道交通金属、储能、超导等先进材料研发。德国 MLZ 研究中心是全球顶尖高通量中子科研平台，我国 CSNS 为国内首台脉冲散裂中子源，双方长期围绕残余应力测试、数据分析标准化、实验设备迭代开展合作，并定期举办学术研讨会培育青年科研人员。

本次活动分为两大板块：一是中德专家主题论坛，汇聚德国 MLZ 研究中心、匈牙利罗兰大学及中方散裂中子源著名学者，围绕各类中子衍射技术在工程材料领域的应用展开交流，探讨未来中德多学科、多层级长效合作机制；二是中子全衍射轮廓拟合专项辅导班，由 CMWP 方法开创者 Tamás Ungár 教授和 Gábor Ribárik 教授领衔授课，系统讲解衍射峰形与晶体缺陷理论模型，并结合实测中子衍射数据开展一对一软件实操，实现金属材料位错、应变、层错、孪晶等微观结构定量分析实操教学。

活动为期 6 天，设置理论报告、专题研讨、CSNS 装置参观、软件实操等环节，搭建中德中子散射领域青年科研人才交流实训平台，推进两国工程材料中子表征技术标准化与联合科研创新。

## 二、会议时间与地点

| 会议名称 | 中德工程材料中子散射论坛 | 中子全衍射轮廓拟合辅导班 |
| --- | --- | --- |
| 时间 | 2026 年 9 月 13-16 日，13 日报到 | 2026 年 9 月 15-18 日，15 日报到 |
| 地点 | 东莞帝豪花园酒店 | |
| 地址 | 中国广东省东莞市大朗镇美景大道 769 号 | |

**三、主办单位**

中国科学院高能物理研究所、散裂中子源科学中心

**四、会议组委会**

主席：陈和生

委员：王生、梁天骄、Michael Hofmann、甘为民、李小虎

**五、论坛专家阵容**

**专家简介及报告摘要（将持续更新中）**

**Dr. Michael Hofmann**

• Forschungsneutronenquelle Heinz Maier-Leibnitz (FRM II)

• Technical University Munich

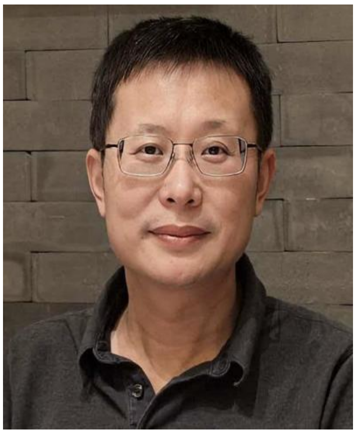
• Group leader STRESS-SPEC

• Coordinator Materials Science Group

报告题目：Overview on the outcomes of the mobility program from the FRM II/TUM perspective

报告摘要：

In the presentation I will give a short overview on the work which has been done in course of the collaboration between the EMD group of CSNS and the STRESS-SPEC team from FRM II (Technical University Munich). Besides training and teaching activities several scientific topics like standardization in residual stress measurements, software developments and the deformation behavior of sheet metals will be briefly highlighted. These topics will be further elaborated in subsequent more focused talks of group members of the STRESS-SPEC group.



**Dr. Weimin Gan**

• German Engineering Materials Science Centre (GEMS) at Heinz Maier-Leibnitz Zentrum (MLZ) Helmholtz-Zentrum Hereon

• Senior Researcher, Neutron Instrument Scientist

报告题目：Effect of laser beam shaping on the crystallographic texture and residual stress distribution of 316L stainless steel manufactured using Laser Powder Bed Fusion

报告摘要：Laser Powder Bed Fusion (PBF-LB) has attracted significant attention in aerospace, automotive, and biomedical applications due to its highly flexible and near-net-shape fabrication capabilities for complex structures. While PBF-LB overcomes the limitations of conventional manufacturing methods by enabling lightweight and functionally integrated designs, traditional Gaussian laser-based L-PBF suffers from low productivity and high residual stresses due to small melt pools, rapid cooling rates, and steep thermal gradients. Laser beam shaping techniques, such as ring-mode lasers, offer improved energy distribution, enhanced melt pool stability, and potentially higher build rates. However, their effects on residual stress, microstructural texture, and mechanical properties remain unclear. This study systematically investigates the influence of Gaussian versus ring-mode lasers on the as-built microstructure (e.g., dislocation structures, elemental segregation), crystallographic texture, and residual stress in

316L austenitic stainless steel using advanced characterization techniques, including electron backscatter diffraction (EBSD) and neutron diffraction. The findings aim to optimize process parameters for superior mechanical performance, providing critical insights for the potential application of beam-shaped PBF-LB on fusion energy and nuclear industrial components.

**Dr. Baohu Wu**

- Forschungszentrum Juelich, JCNS-MLZ
- Instrument Scientist for KWS-3 and KWS-X
- Head of MLZ SAXS Lab
- SSB (Radiation Protection Officer)
- Senior Scientist

报告题目：Current Status and Development of Small-Angle Scattering Instruments at MLZ

报告摘要：Small-angle neutron scattering (SANS) is a vital technique for probing the nanoscale to mesoscale architecture of complex materials. Within the Heinz Maier-Leibnitz Zentrum (MLZ) framework, a collaborative synergy among Forschungszentrum Jülich (FZ-Jülich), the Technical University of Munich (TUM), and Hereon has established the world’s highest-density suite of SANS instruments at a single facility. This presentation provides a comprehensive overview of this premier instrumental ecosystem and its impact on multidisciplinary research.

The suite currently comprises three state-of-the-art conventional pinhole SANS instruments(KWS-1,KWS-2, SANS-1), a focusing-lens SANS instrument(KWS-3), and several neutron spectrometers capable of specialized SANS functions (REFSANS and RESEDA) offering exceptional versatility across diverse structural length scales. Developed and continuously upgraded over decades, these instruments are optimized for high neutron flux, excellent resolution, and highly adaptable sample

environments.

This infrastructure serves a global user community investigating large-scale structures across various fields, including soft matter, magnetic materials, thin films, biomaterials, and engineering materials. We will highlight how these SANS capabilities drive breakthroughs in complex systems and emphasize the suite’s vital role in advanced material characterization, particularly through the implementation of complex in-situ and operando sample environments for real-time testing.

Ultimately, this overview demonstrates how the MLZ SANS suite empowers researchers to address challenging structural questions and foster innovation across both fundamental and applied sciences.


**Lorenz Maier**

- Technical University of Munich
- Chair of Material Forming and Casting
- M.Sc. Lorenz Maier
- Research Associate


报告题目：Multiscale Investigation of Deformation in Dual-Phase Steel under Non-Proportional Loading


报告摘要：This study investigates the micromechanical deformation behavior of the dual-phase steel DP800HHE under biaxial and non-proportional loading conditions by combining in-situ neutron diffraction experiments with multiscale numerical simulations. The objective is to evaluate the predictive capability of a crystal plasticity framework for complex loading paths and to improve the understanding of phase-specific deformation mechanisms.

Three representative loading paths were examined: (I) purely biaxial tensile loading, (II) plane strain tension followed by biaxial tension,

and (III) biaxial tension followed by plane strain tension. These loading paths were selected to capture both proportional and non-proportional deformation behavior. The macroscopic stress response was determined using finite element simulations that reproduced the experimental specimen geometry and loading conditions. The resulting stress histories served as input for crystal plasticity simulations.

Based on the crystal plasticity simulations, phase-resolved lattice strains for ferrite and martensite were calculated and compared with the experimentally measured lattice strain evolution obtained from in-situ neutron diffraction. This comparison enabled a detailed validation of the simulation framework across different deformation paths and loading transitions.

The results demonstrate that the dislocation-density-based crystal plasticity model captures both the macroscopic stress response and the phase-specific lattice strain evolution with good accuracy for all investigated loading paths. In particular, the framework successfully reproduces the effects of load-path changes and the associated micromechanical response. These findings confirm the suitability of the proposed multiscale simulation approach for predicting deformation behavior in dual-phase steels under complex biaxial loading conditions and provide valuable insight into the underlying phase interactions during non-proportional deformation.

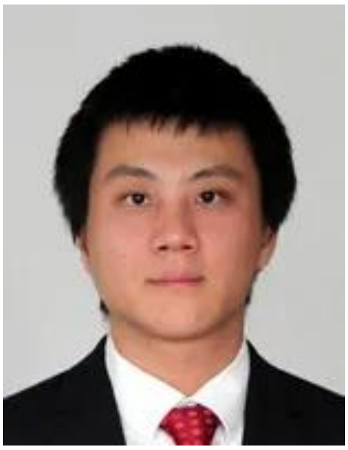
Dr. Ammar NEJATI

- Scientific Computing Group (SCG)
- Forschungszentrum Jülich,
- Jülich Centre for Neutron Science (JCNS)
- Scientific Software Engineer

报告题目：Time-of-Flight Diffraction in Steca for the CSNS-EMD Detector

报告摘要：Steca (Stress and Texture Calculator) was originally designed for monochromatic measurements on flat area detectors. Extending it to the time-of-flight (ToF) modality of the EMD at CSNS requires a radically different treatment: a pulsed, polychromatic neutron beam makes the pattern energy-dispersive, and the lattice spacing d is sampled through the neutron arrival time rather than through the detector angle.

This talk reports the status of the collaboration with the EMD team and the resulting implementation in Steca.



**Lijiu Wang**

- MLZ – TU Munich
- research assistant

报告题目：Robotic Sample Manipulation at STRESS-SPEC with Optical Feedback

报告摘要：Materials and components with intricate geometries, such as from additive manufacturing (AM), require highly flexible sample positioning systems during spatially resolved diffraction experiments. Therefore, the STRESS-SPEC group at Heinz Maier-Leibnitz Zentrum (MLZ), Germany, has pioneered the use of industrial robots to enhance sample handling and positioning at neutron diffractometers [1, 2]. While these robots may easily position the sample in the desired directions and orientations, their absolute accuracy of up to ±0.5 mm has been insufficient for precise local measurements so far. To allow accurate full strain tensor determination and accurate centering of local texture measurements, a positioning accuracy within 10% of the gauge volume size is required, which may be as small as 1 $mm^3$ on modern neutron diffractometers [3]. To address this limitation, we have upgraded the

STRESS-SPEC robotic system with an optical metrology setup that actively tracks and corrects the sample position within a spatial accuracy of better than 50 μm. We will present the complete measurement process chain and challenges during the integration of the robot.

Furthermore, a versatile laser furnace with a large neutron acceptance angle for temperatures up to 1200° C and a lightweight tensile testing machine are currently being built to be mounted on the robot flange. Together with the optical feedback system, the most common experimental scenarios are covered in a semi-automated measurement environment.

[1] H.-G. Brokmeier et al., Mater. Sci. For. 652 (2010) pp. 197–201. DOI: 10.4028/www.scientific.net/MSF.652.197

[2] C. Randau et al., Nucl. Instr. Meth. A 794 (2015) pp. 67–75. DOI: 10.1016/j.nima.2015.05.014

[3] R. Ramadhan et al., Nucl. Instr. Meth. A 999 (2021) 165230. DOI: 10.1016/j.nima.2021.165230

## 六、日程安排

整体分为中子应用论坛与轮廓拟合专项辅导班两大板块：

1.中德工程材料中子散射论坛（2026 年 9 月 13-16 日）

| 日期 | 内容 |
| --- | --- |
| 9 月 13 日下午 | 报到 |
| 9 月 14 日上午 | 会议开幕式、领导致辞、嘉宾介绍<br>中德项目组双方汇报和项目总结 |
| 9 月 14 日下午 | 外部专家邀请报告，中德项目成果汇报 |
| 9 月 15 日上午 | 散裂中子源谱仪报告 |
| 9 月 15 日下午 | 德国 FRM II 谱仪报告 |

| 日期 | 内容 |
| --- | --- |
| 9 月 16 日上午 | 参观 CSNS |

2.中子全衍射轮廓拟合辅导班（2026 年 9 月 15-18 日）

| 日期 | 内容 |
| --- | --- |
| 9 月 15 日下午 | 报到 |
| 9 月 16 日 | 线轮廓分析的实践要点与理论基础 |
| | 安装基于 DEBIAN 的 Linux 发行版及 CMWP 软件包，并对已安装的 CMWP 软件包进行简要测试 |
| 9 月 17 日 | 尺寸扩大的基本原理 |
| | 立方和六方晶系材料中的应变各向异性及位错对比因子 |
| | CMWP 程序的工作原理 |
| | 软件实践（一）：数据准备 |
| | 软件实践（二）：立方晶体中晶粒尺寸与位错密度的定量表征 |
| | 软件实践（III）：六方晶中晶粒尺寸与位错密度的定量表征 |
| 9 月 18 日 | 平面缺陷对衍射峰形的影响 |
| | 布拉格峰下方的卫星散射与漫散射现象 |
| | 不对称峰与重叠峰的评估 |
| | 软件实践（四）：衍射图谱序列的自动评估 |
| | 软件实践（五）：平面缺陷的定量表征 |

| 日期 | 内容 |
| --- | --- |
| | 软件实践（六）：六方晶系中多种滑移系统的定量表征 |

注：本次活动全程以英语交流与授课；整体日程将根据实际情况持续更新。

**七、会议费用**

1. 会议注册费

**中德工程材料中子散射论坛**：不收取任何会议注册费。

**中子全衍射轮廓拟合辅导班**：培训费 2500 元 / 人。待第二轮通知公布培训人员名单后再缴费。

2.参会人员可入住东莞帝豪花园酒店（会议地点），收费标准 450 元 / 间 / 晚，费用自理。住宿费可现场支付现金（人民币）或刷卡支付。

3.参会人员的交通费用自理。会务组提供会议期间午餐费用，晚餐自理。

**八、报名通道**

1.中德工程材料中子散射论坛（2026 年 9 月 13-16 日）

**参会名额限定 30 人，按照报名先后顺序录取，报满即刻截止。**

2. 中子全衍射轮廓拟合辅导班（2026 年 9 月 15-18 日）

请提前准备个人简历（简历全部内容须使用英文撰写，不超过 2 页），含职务、依托单位、研究方向、学术经历等，并将简历同步上传至以下报名二维码。**为保障授**

**课质量，会务组将根据简历筛选 20 名人员参加本次授课。**

**报名截止时间为 7 月 15 日，预计 8 月公布参加培训人员名单。**

3.若两项活动（论坛 + 培训班）都要参加，以上两个报名二维码均需扫码填写报名。

## 九、会议联系

余洁莹（yujy@ihep.ac.cn）综合咨询

常俊然（changjr@ihep.ac.cn）注册申请