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High Accuracy Optical Feedback System for Robotic Sample Manipulation at STRESS-SPEC

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Materials and components with intricate geometries, such as from additive manufacturing (AM), require highly flexible sample positioning systems during diffraction experiments. Therefore, the STRESS-SPEC group at Heinz Maier-Leibnitz Zentrum (MLZ), Germany, has pioneered the use of industrial robots [1, 2] to enhance sample handling and positioning at neutron diffractometers. 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. 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 with a spatial accuracy of better than $50\text{ }\mu\text{m}$. We will present the complete measurement process chain and verification steps for this improved sample positioning system.

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

Author: WANG, Lijiu

Co-authors: KUMMER, Felix; Mr KRUEGER, Jens; Dr REBELO KORNMEIER, Joana (MLZ); Prof. FRANKE, Jörg (FAPS Erlangen); Prof. LANDESBERGER, Martin (MLZ/TH Ingolstadt); HOFMANN, Michael; Mr KEDILIOGLU, Oguz (FAPS Erlangen); Prof. MAYR, Peter (MAE - TUM); DANTAS BAUER, Rafaella; Dr REITELSHÖFER, Sebastian (FAPS Erlangen); VINOD, Shobin; Dr GAN, Weimin (Helmholtz-Zentrum Hereon)

Presenter: WANG, Lijiu

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