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Enhancing Scientific Research and FAIR Data Management Through a Cloud-Based Web Application Platform: FUSE (FAIR Unified Scientific Environment) for the XPCS Use Case in the DAPHNE4NFDI Project

The DAPHNE4NFDI (Data from Photon and Neutron Experiments for the National Research Data Infrastructure) initiative aims to revolutionize data management practices within the photon and neutron science communities by embedding the principles of FAIR data—Findability, Accessibility, Interoperability, and Reusability. Addressing the challenge of unifying diverse datasets and research findings within this specialized scientific field, the project leverages innovative solutions, including dynamic metadata frameworks, expansive data lakes, and user-centered platform designs. This paper discusses the creation of FUSE (FAIR Unified Scientific Environment), a platform that promotes effective research data sharing and utilization. Under the umbrella of the DAPHNE4NFDI project, the X-ray Photon Correlation Spectroscopy (XPCS) method serves as a representative use case to showcase the platform's capabilities. A key feature of FUSE is its ability to enable direct access to reduced/output scientific data from multiple sources, seamlessly integrating these with appropriate metadata items. This integration ensures standardized and comprehensive data descriptions, fostering enhanced interoperability, reproducibility, and data usability across the research community. Additionally, this paper delves into the architecture of FUSE, emphasizing its user-centric design, and explores its impact on facilitating collaborative scientific research. The implementation of experiment classes, dataset instances, Electronic Lab Notebooks (ELN), and sample instances are discussed to underscore their contributions toward achieving a comprehensive and efficient research data management system.

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