One Year Ahead of Full Deployment at HEPS:

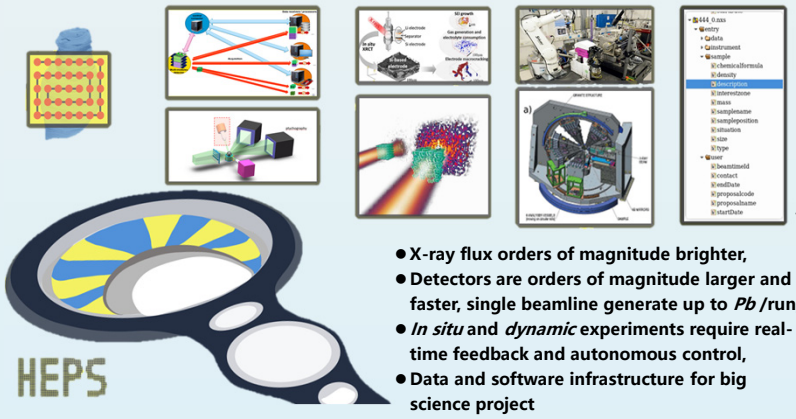
The Status of Mamba Project

Email : zhangyi88@ihep.ac.cn

INSTITUTE OF HIGH ENERGY PHYSICS CHINESE ACADEMY OF SCIENCES

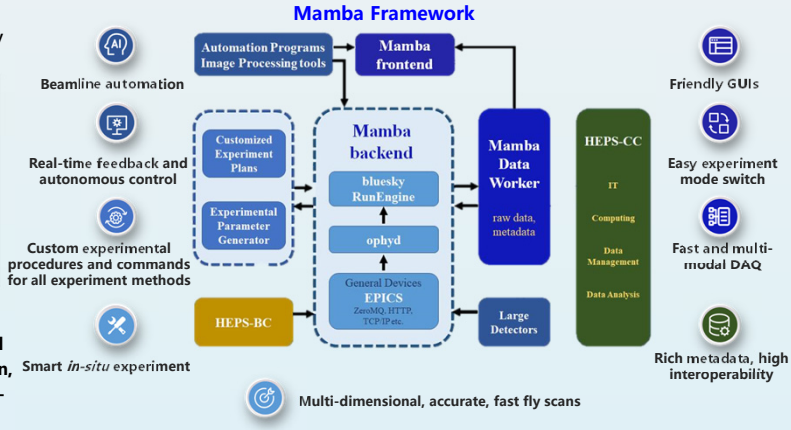
Drastic Increase in Data and Experiment Complexity

1 Nano & Macro Probe | 2 High throughput & Multi-modal | 3 In-situ & Dynamic Experiments | 4 Beamline Automation & Intelligent Control | 5 National Data Management Policy



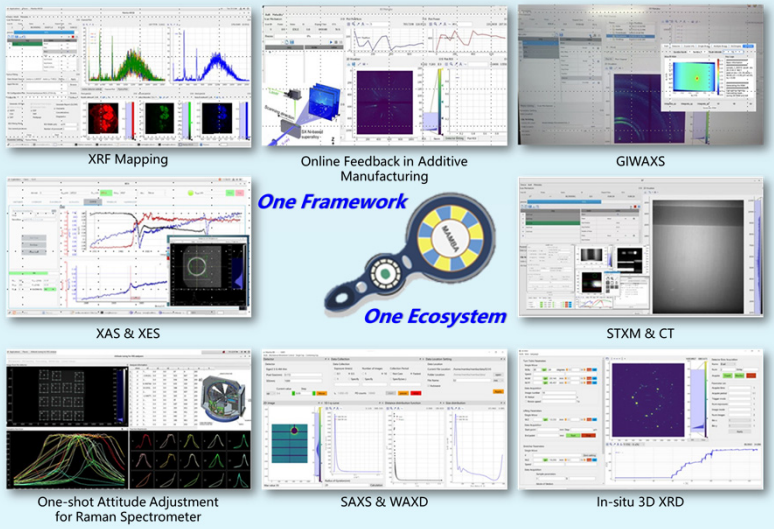
- X-ray flux orders of magnitude brighter,
- Detectors are orders of magnitude larger and faster, single beamline generate up to *Pb* /run,
- *In situ* and *dynamic* experiments require real-time feedback and autonomous control,
- Data and software infrastructure for big science project

A New Generation Synchrotron Experiment Operating Software System (Mamba)

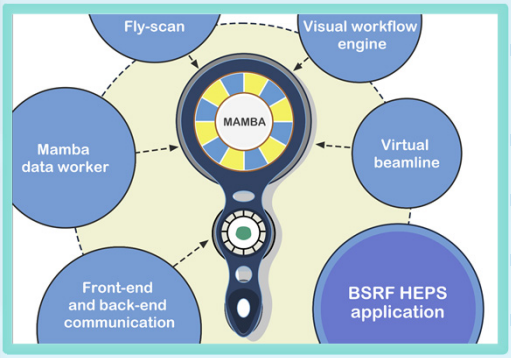


Mamba: a systematic software solution for beamline experiments at HEPS. *Journal of Synchrotron Radiation*, 2022

Test and Deployment of Mamba at BSRF



Explore Key Techniques of New Generation Control and Acquisition System

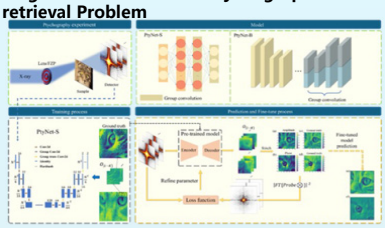


- Python IOC, Systematic detector integration and high-performance readout
- Beamline and experiment specific plan and GUI library
- Versatile attitude tuning frame-work and beamline automation
- Closed-loop control based on real-time data analysis
- AI-Enabled experimental control

Liu et al. *J. of Synchrotron Radiat.* 29(3), (2022) ; Zhang et al. *J. of Synchrotron Radiat.* 30(1), (2023) ; Li et al. *J. of Synchrotron Radiat.* 30(6), (2023); Li et al. *Synchrotron Radiat. News*, (2023); Wang et al. *J. of Synchrotron Radiat,* (2024);

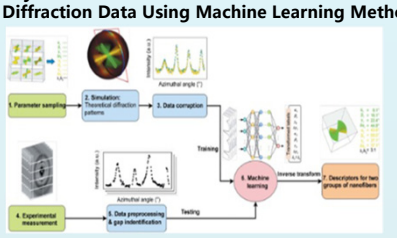
"AI For Science" Applications in Diverse Methodologies

➢ Large AI Model Solves Ptychographic Phase retrieval Problem



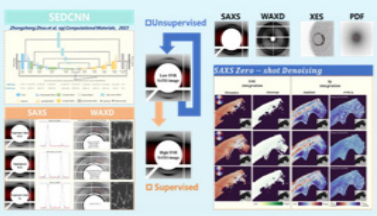
X.Y. Pan et al. *iScience*, 2023; X.Y. Pan et al. *Acta Physica Sinica*, 2023

➢ Physical Information Retrieval From Massive Diffraction Data Using Machine Learning Methods



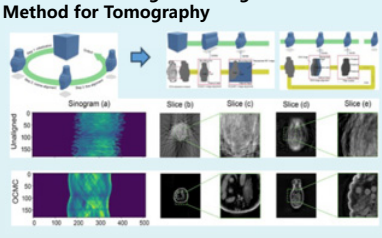
M. Sum et al. *IUCrJ*, 2023; X. Zhao et al. *IUCrJ*, 2024

➢ Physics-informed Denoising Solution



Z.Z. Zhou et al. *npj Comp. Mater.*, 2023; Z.Z. Zhou et al. *Journal of Appl. Crystallogr.* accepted

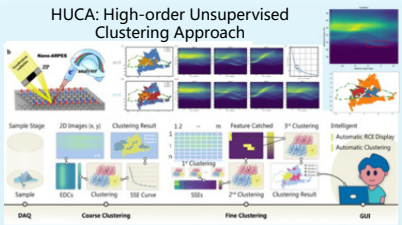
➢ End-to-end Image Misalignment Correction Method for Tomography



Z. Zhang et al. iScience, 2023

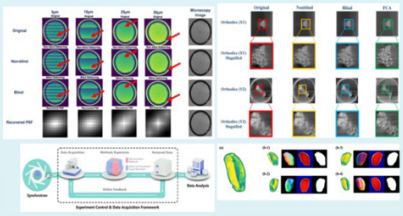
➢ Clustering of Nano-ARPES Experimental Spectra

HUCA: High-order Unsupervised Clustering Approach



L.Z. Bian et al. Commun. Phys., under review

➢ Deconvolution and Super-resolution Pipeline



C. Li et al. *Nucl. Sci. Tech.*, accepted