SATELLITE WORKSHOP – Photon Science

DIGITAL LEAPS Virtual Diagnostics

Thursday, 29 January 2026

Building on the success of previous editions, this one-day collaborative workshop explores cutting-edge virtual diagnostics—leveraging modern computing techniques (AI/ML, high-fidelity simulations, and real-time data integration) to deepen our understanding and improving the operation of complex accelerator, synchrotron and FEL facilities.

Key topics include:

- **AI-driven fidelity augmentation** of photon and electron diagnostics (e.g., high-repetition-rate photoelectron spectra, streaking-cavity-based energy loss measurements).
- **Full FEL/AI models** as a foundation for virtual diagnostics, enabling rapid simulation of photon pulses and electron beam properties.
- **Predictive machine learning** for real-time photon pulse properties (e.g., in the time domain) using online diagnostic inputs.
- **Integration of virtual diagnostics into machine operation**, bridging simulations and experimental data for adaptive control.
- **Automated pipelines** for online analysis, from passive/active streaking cavity data to single-shot X-ray power profiles.

The workshop aims to foster cross-disciplinary collaboration among experts in accelerator physics, photon science, AI/ML, and diagnostics, to accelerate the deployment of virtual tools for existing and next-generation facilities.

Organisers: R. Kammering, K. Tiedtke, S. Tomin

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Morning: Electron-Beam Virtual Diagnostics		
09:00-09:05	Welcome & Introduction	
Session 1		**Chair: Serguey Tomin**
09:05-09:30	Longitudinal phase space diagnostics / Virtual diagnostics at the EuXFEL	B. Veglia, DESY
09:30-09:55	Algorithmic Reconstruction of nD Phase Space from Beam Measurements and Simulations	T. Overton, STFC
09:55-10:20	Virtual Diagnostics for Longitudinal Phase Space Predictions	J. Lundquist, MAX IV
10:20-10:40	Discussion	
10:40-11:10	*Coffee break*	
Session 2		**Chair: Raimund Kammering**
11:10-11:35	Longitudinal Phase Space Reconstruction in the KEK Injector Linac	A. Polo, DESY
11:35-12:00	A Machine-Learning Framework for Transverse and Longitudinal Phase-Space Diagnostics at PITZ	X. Li, DESY
12:00-12:20	Discussion	
12:20-14:00	*Lunch break*	
Afternoon: Photon-Beam Virtual Diagnostics		
Session 3		**Chair: Kai Tiedtke**
14:00-14:25	Photo Injector Surrogate Modeling with Temporal Laser Pulse Shaping	J. Kwasniok, EuXFEL
14:25-14:50	Unsupervised ML approach for power profile reconstruction	G. Goetzke, DESY
14:50-15:15	Enabling Closed-Loop Experimentation Using Online FEL Pulse Characterization	K. Dingel, Uni Kassel
15:15-15:45	*Coffee break*	
15:45-16:10	Advanced photon-beam diagnostics at SwissFEL: methods, examples, and future directions	C. Arrell, PSI
16:10-16:35	Data science enhanced spectral and temporal characterization	D. E. Ferreira de Lima, EuXFEL
16:35-17:00	TBD	Y. Murooka, Univ. Liverpool
17:00-17:20	Final Discussion	
17:20-17:30	Closing Remarks and end of workshop	