TUT 1: Hands-on Tutorial: HyperSpy – Multidimensional data analysis using Python (joint session FM/TUT)

HyperSpy is a community-developed, open-source library providing a framework to facilitate interactive analyses of multidimensional datasets – in particular spectrum images – in an easy and reproducible fashion. It facilitates the application of analytical procedures operating on individual spectra/images to a multi-dimensional dataset and gives easy access to tools that exploit the multi-dimensionality of the dataset. Born out of the electron microscopy scientific community and building on the extensive scientific Python environment, HyperSpy provides tools to efficiently explore, manipulate, and visualize complex datasets of arbitrary dimensionality, including those larger than a system's memory. The HyperSpy ecosystem includes Python packages that provide dedicated routines for many electron microscopy-based measurement techniques, but also for luminescence spectroscopy and other fields. Through the library RosettaSciIO, the reading and writing of a large range of file formats is supported.

Please bring your laptop. There will be limited power outlets in the room, so come with a fully charged battery.

Materials will be made available from 01.03.2026 via a dedicated GitHub repository. Participants are encouraged to download them ahead of time, set-up Python on their computer following the instructions and run the jupyter notebooks presented during the tutorials on their laptops:

https://github.com/LumiSpy/DPG2026-Tutorial

Organized by Jonas Lähnemann (PDI Berlin), Benedikt Haas (HU Berlin), Aidan Campbell (PDI Berlin), Hannah C. Nerl (HU Berlin) and Magnus Nord (NTNU Trondheim).

Time: Sunday 16:00–18:15 Location: HSZ/0002

TUT 1.1 Sun 16:00 HSZ/0002

Introduction to HyperSpy — •Jonas Lähnemann[1], Aidan F. Campbell[1], Hannah C. Nerl[2], Magnus Nord[3], and Benedikt Haas[2] — [1]Paul-Drude-Institut für Festkörperelektronik, Berlin, Germany — [2]Department of Physics, Humboldt Universität, Berlin, Germany — [3]Department of Physics, Norwegian University of Science and Technology, Trondheim, Norway

The session begins with a brief introduction to HyperSpy that with its 2.0 release has grown to an ecosystem of Python packages that provide dedicated routines for electron microscopy-based measurement techniques such as EELS, EDX, 4DSTEM, holography, tomography and CL, but also for luminescence spectroscopy. In general, it can be useful for any measurement, where a signal is mapped over multiple dimensions (position, time, angle, ...).

Tutorial TUT 1.2 Sun 16:15 HSZ/0002

Hands-On Session 1: General usage HyperSpy/RosettaSciIO — •Jonas Lähnemann — Paul-Drude-Institut für Festkörperelektronik, Berlin, Germany

In the initial tutorial, we will show how to easily read in data from a variety of formats and introduce the basic data structure of HyperSpy. General data operations, artefact removal and plotting functionalities as a basis of reproducible data analysis workflows will be covered as well.

Tutorial TUT 1.3 Sun 16:45 HSZ/0002

lumiSpy for luminescence spectroscopy — •Aidan Campbell — Paul-Drude-Institut für Festkörperelektronik, Berlin, Germany

This session will focus on tools ideal for analysing data recorded with cathodoluminescence, photoluminescence or related spectroscopy techniques. We will demonstrate convenience functions for rapid spectroscopy data analysis, model fitting, and visualisation. Luminescence spectroscopy may also lead to more complicated data sets with spectral, spatial and time dimensions for which we showcase interactive tools for navigating and understanding this data.

Tutorial TUT 1.4 Sun 17:15 HSZ/0002

Hyperspy for Electron Energy-loss Spectroscopy — •Hannah Nerl — Humboldt Universität zu Berlin, Berlin, Germany

This hands-on session demonstrates a complete electron energy-loss spectroscopy (EELS) analysis workflow using HyperSpy and its exSpy extension. Participants will work through practical examples covering essential preprocessing steps including spectral alignment and drift correction, followed by quantitative analysis techniques such as model-based peak fitting and automated peak tracking across multi-dimensional datasets. The tutorial emphasizes reproducible analysis pipelines, showcasing how to leverage principal component analysis (PCA) for noise reduction in low-signal regimes. All examples use real EELS datasets and focus on practical workflows applicable to both core-loss and low-loss spectroscopy of 2D materials and nanostructures. Participants will gain hands-on experience with Jupyter notebooks that can be directly adapted to their own research data.

Tutorial TUT 1.5 Sun 17:45 HSZ/0002

Using pyXem for magnetic and structural analysis of 4D-STEM data — •Magnus Nord — Norwegian University of Science and Technology, Trondheim, Norway

pyXem is an extension of HyperSpy with a focus on data processing of 4D-STEM data: from crystallographic analysis using Scanning Precession Electron Microscopy (SPED), to magnetic imaging with Scanning Transmission Electron Microscopy - Differential Phase Contrast (STEM-DPC). In this tutorial, we will show how one can study the crystal structure and domain structure in a nanostructured magnetic material.