Astro- and Particle Physics

Radio galaxies
• Classification with convolutional neural networks
• Automation is crucial for next generation of radio telescopes
• Training data is limited
• Improving classifiers with augmentation based on GANs
  → Benefit from knowledge acquired in calorimeter simulation in HEP

Postdocs: Janis Kummer, Lennart Rustige

Jet resolution at CMS
• Very time-consuming simulation of the detector with Geant4 (full)
• Analytical smearing (fast) good enough for searches but not for precision measurements
  → Refine fast simulation with WGAN!

Postdoc: Patrick L.S. Connor
Student: Sven Harder

PETRA III & European XFEL (EuXFEL)
• Develop techniques for high-intensity photon sources such as PETRA III synchrotron (picture) and the EuXFEL
  → e.g. using serial crystallography.
• Probe millions of tiny crystals using intense X-ray beam
  → Terabytes of raw data per experiment.
  → Reduce data down to a small data array used to determine the structure of the protein.

Artistic 3D representation of X-ray crystallography data:
Large photosynthetic protein complexes acquired from thousands of tiny crystals probed using an X-ray free-electron laser

Photon Science

Systems Biology

Modelling protein interactions
• Proteins = long strings of amino acids folding into an energetically stable 3D structure (A).
• Protein-protein interactions (PPIs) mediate both normal cellular functions, as well as those involved in disease.
  → e.g. SARS-CoV2 gains entry into the human host cell through an interaction between its spike protein and the human ACE2 receptor protein (B; boxed region = interaction interface).
  → Repurpose attention-based ML methods to predict PPIs (C)
  → Validate PPI predictions experimentally through cryo-electron microscopy

Complex control systems
• Large-scale infrastructures with multi-layered, highly distributed hardware-software architecture
  → High volume of data from many components.
  → High speed processing to control of the underlying physics.
• Develop novel approaches for control, diagnosis, optimization, and maintenance in infrastructures such as EuXFEL
  → “Big data” approach.
  → Increase scientific precision and system availability.
  → Currently investigating Xilinx ACAP AI-Series

Control of Accelerators

Join our Symposium on 26-28 April 2022 in Hamburg!
https://indico.desy.de/event/31214/